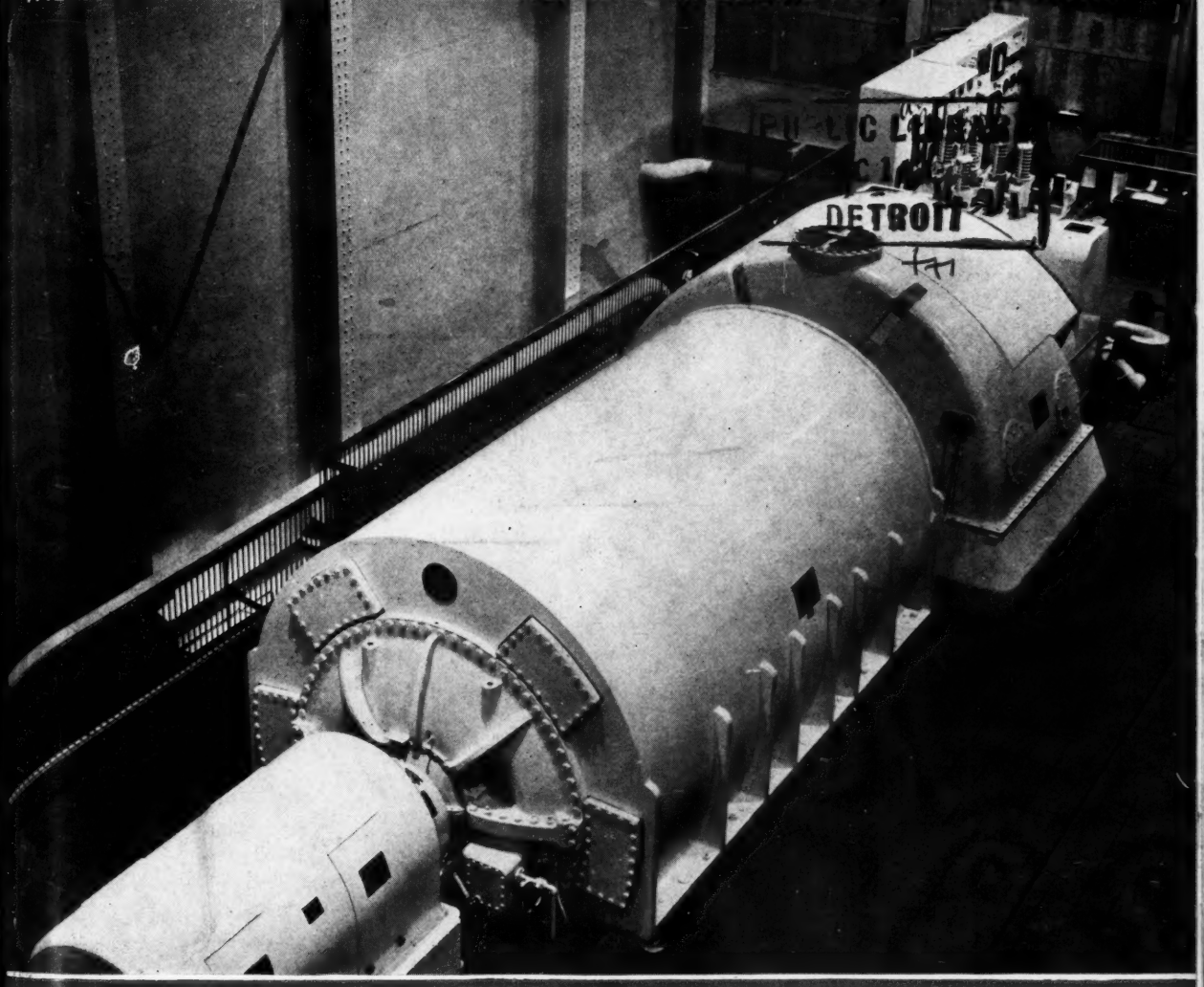
POWER PLANT ENGINEERING

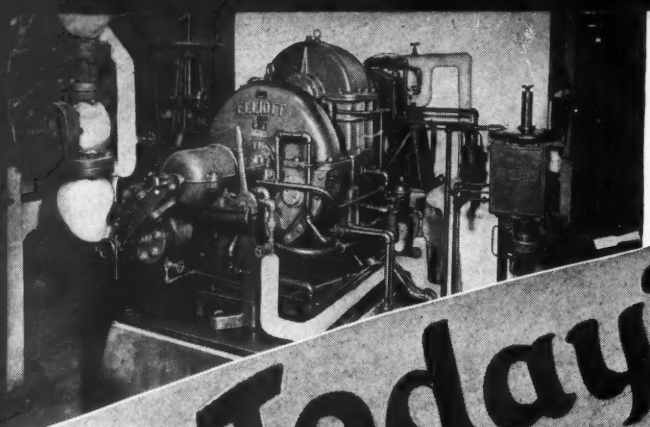
THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



Engineering Features At Silver Gate Station
History And Development Of Electronic Power Converter
Costs Of Units At Woodcock Station
The Mechanical Electrical Dust Collector
What Engineers Should Know About Centrifugal Pump Control

Contents Page 5 . . . Yearly Index Pages 205-210

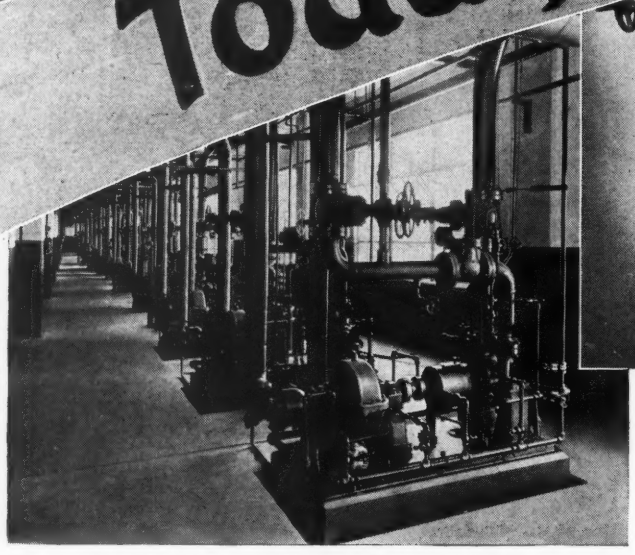
DECEMBER
1944

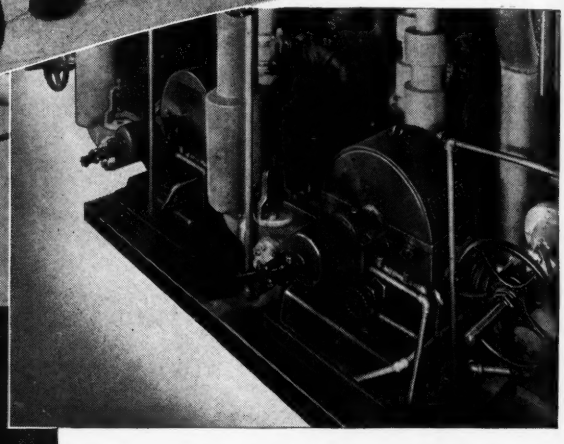


PUMPS

Elliott turbine with built-in gear driving an induced draft fan in the steam generating plant of a large aircraft manufacturer.

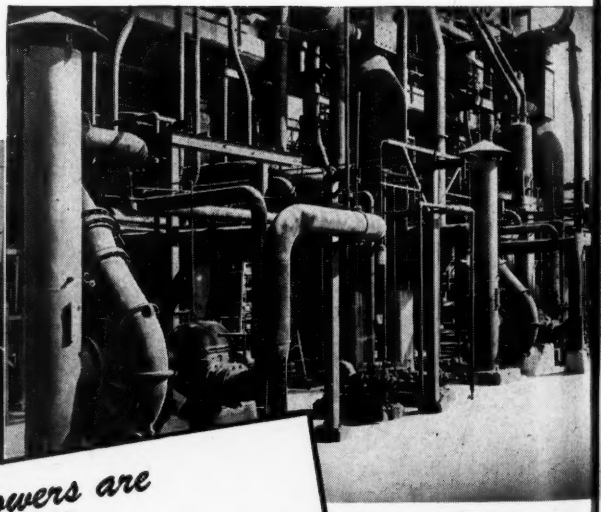
Today's drives

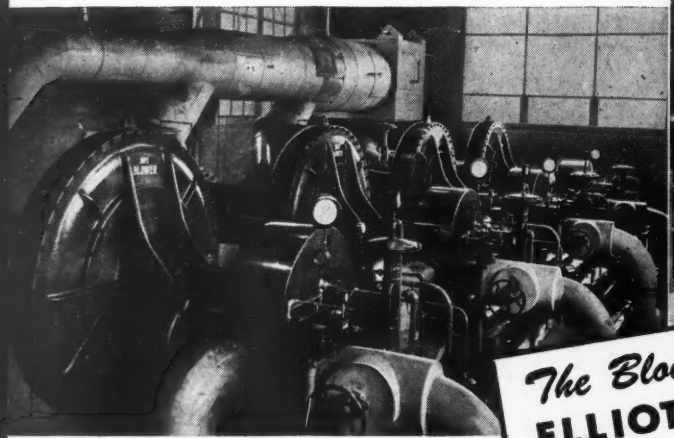




PUMPS These Elliott turbines are typical of hundreds driving boiler-feed pumps in all sorts of steam plants.

PUMPS A long line of Elliott turbines direct-connected to pumps in a high-octane gasoline refinery.





The Blowers are ELLIOTT *too*

The blowers in the photographs above are built by Elliott as well as the turbines which drive them. Elliott blowers, too, are sturdy and dependable, rugged and heavy, giving practically vibrationless and quiet operation.

BLOWERS Four Elliott turbines direct-connected to Elliott blowers handling flue and kiln gas in a magnesium plant. Turbines are equipped with variable speed oil type governors.

BLOWERS Three Elliott blowers in catalyt cracking service, driven by Ellio condensing turbines operating 500 lb, 600 deg steam. Outdo installation. Other Elliott turbin are driving pumps.

ELLIOTT COMPANY

Steam Turbine Dept., JEANNETTE, PA.

DISTRICT OFFICES IN PRINCIPAL CITIES

STEAM TURBINES
HEATERS AND DEAERATORS
FOR DIESEL ENGINES

demand dependable

ELLIOTT Turbines

Reliability was always important in mechanical drive turbines. Today's conditions demand it more than ever before. Around-the-clock, 24-hour service is the usual thing. Units have to stay on the line "in spite of hell or high water." On top of that, in many plants there are no standby units, due to wartime curtailment.

The Elliott turbines pictured are all on 24-hour service, many in plants making critical war materials such as high-octane gasoline, magnesium, etc. These Elliott turbines, as expected, are giving a good account of themselves and are proving that they have "got what it takes" for continuous non-stop service.

Elliott turbines, you probably know, are always heavier, are more substantially built, have more material in them than the usual turbine. This gives the added factor of safety required for wartime service. At the same time, they have all of the refinements and safety features you require of a steam turbine.

Construction details are given in descriptive bulletins sent on request. An Elliott turbine engineer near you will be glad to talk over your specific job and make suggestions.

H-686

GENERATORS · MOTORS · CONDENSERS
STEAM JET EJECTORS · CENTRIFUGAL BLOWERS
TUBE CLEANERS · STRAINERS
FEEDWATER
TURBOCHARGERS
DESUPERHEATERS · FILTERS

Diesel Workhorses

DIESEL hauls Diesel as sturdy tractors pull Diesel locomotives ashore on an invasion beachhead . . . dramatizing another example of the many uses to which these "workhorse" engines are being put these days.

On land and sea . . . in mobile and stationary installations . . . full-power, dependable Diesel operation is, to a great extent, a matter of dependable lubrication . . . assured with Texaco Ursa Diesel lubricants.

Texaco Ursa Diesel lubricants constitute a complete line of oils that prevent scuffing, thereby increasing life of rings, pistons and liners. They keep rings free in their grooves, valves active, ports clear, assuring full piston seal that means maximum economy, and longer periods between overhauls. They also protect modern alloy bearings. Because of these benefits—

More stationary Diesel hp. in the U.S. is lubricated with Texaco than with any other brand.

A Texaco Lubrication Engineer, specializing in Diesel lubrication, will gladly recommend the most suitable type and grade of *Texaco Ursa Oil* for your engine. Phone the nearest of more than 2300 Texaco distributing points in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Lubricants and Fuels

FOR ALL DIESEL ENGINES

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

POWER PLANT ENGINEERING

Editorial Staff

ARTHUR L. RICE
Editorial Director

RALPH E. TURNER
Editor

ANDREW W. KRAMER
Managing Editor

CHESTER R. EARLE
Associate Editor

RICHARD H. MORRIS
Engineering Editor
On leave with U. S. Army Air Forces

Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

KINGSLEY L. RICE, *President*
EDWIN C. PROUTY, *Vice President*
WALTER PAINTER, *Vice President*
ARTHUR L. RICE, *Treasurer*
CHARLES S. CLARKE, *Secretary*
JOHN O. AARVOLD, *Prod. Mgr.*

Advertising Representatives

CHICAGO: Charles S. Clarke
Richard A. Patterson
53 W. Jackson Blvd., Chicago 4, Ill.
Harrison 0824

NEW YORK: John A. Kershaw
Graybar Bldg., New York 17, N. Y.
Caledonia 5-3779

PHILADELPHIA: H. G. Wilds
121 Waverly Road, Wyncote, Pa.
Ogontz 1066

CLEVELAND: A. H. Van Duyn
627 Union Commerce Bldg.
Cleveland 14, Ohio
Cherry 1377

SAN FRANCISCO: Roy M. McDonald
564 Market St.
San Francisco 4, Calif.
Garfield 8966

LOS ANGELES: Roy M. McDonald
541 S. Spring St.
Los Angeles 13, Calif.
TUcker 7981

WASHINGTON, D. C.
c/o Business News Service
10 Independence Ave.

Contents, December, 1944

VOLUME 48—NUMBER 12

Cover: New 35,000-kw turbine-generator in Silver Gate Station, San Diego Gas & Electric Co.

Front Lines 7

What Leaders Say 67

Compressed Air Geyser 68

With the Editors 69

Silver Gate Station Powers San Diego for War 70
By H. A. Noble and W. A. Zitlau

Centrifugal Pump Control 74
By Igor J. Karassik

Water Power Operated Air Compressors 77

Steam for Super-Octane Gas 78
By J. C. Leslie

Construction Costs at Woodcock 80

History and Development of the Electronic Power Converter 84

Radiant Heating Systems Advance Human Comfort 88
By Charles Hawk

The Mechanical-Electrical Dust Collector 90

Fundamental Facts About Fuel Efficiency 92
By Joseph Harrington

Children, Trees and Power Lines 94
By Leslie Childs

Practical Engineer and Electrician 95

Water Chemist Meet in Pittsburgh 120

Power Facilities at TVA's Fontana Dam—Correction 134

Hendy Power Plants Ordered for Soviet 134

New Equipment 138

Obituaries 150

Manufacturers' News 152

Manufacturers' Personals 154

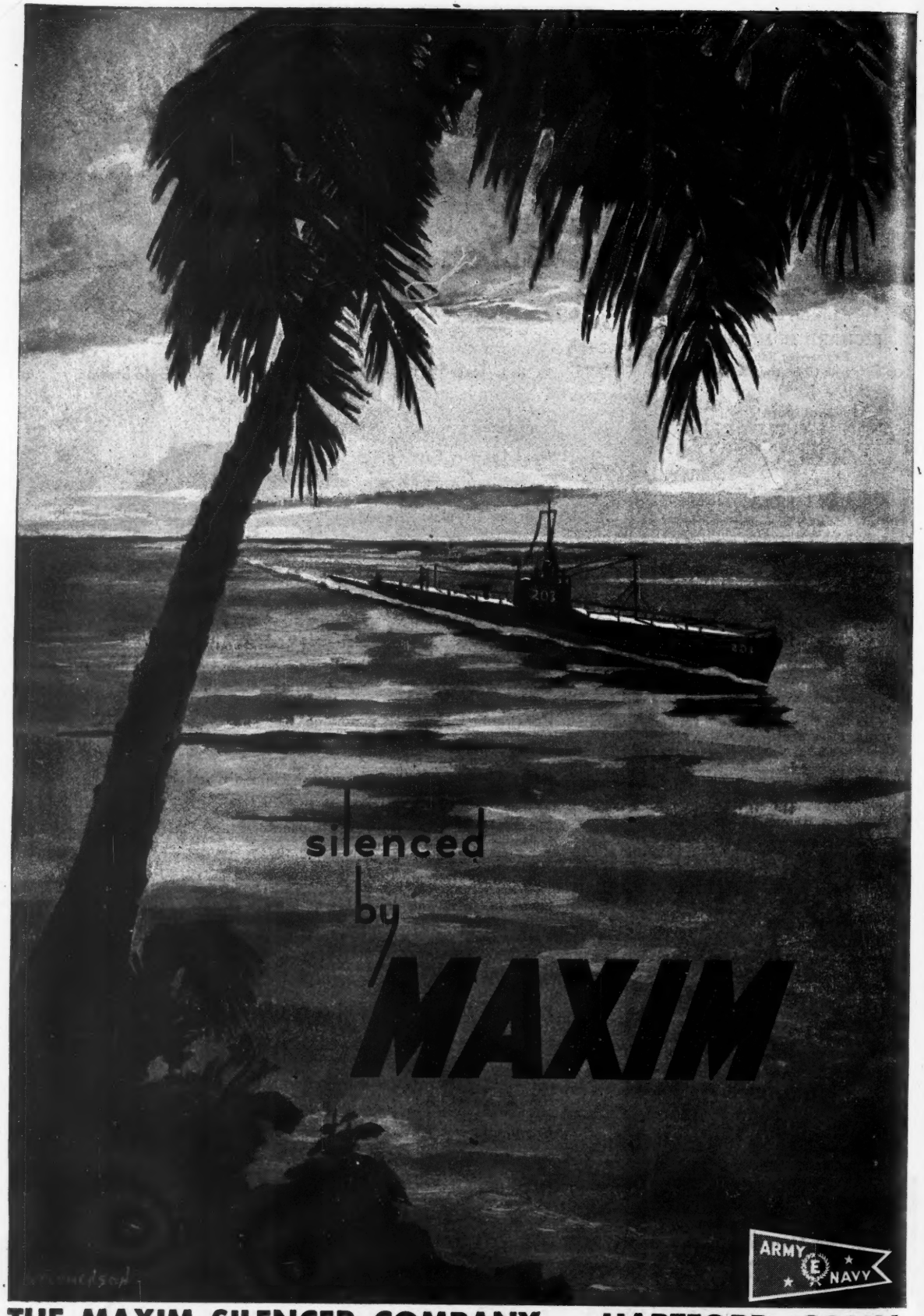
News from the Field 158

Power Plant Construction News 182

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

Copyright 1944, by Technical Publishing Co.

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago 4, Ill., U. S. A. Subscription price, $2.00 a year. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XLVIII, No. 12.



THE MAXIM SILENCER COMPANY . . HARTFORD, CONN.

FRONT LINES

AS AN ANSWER to the problem of adequately training engineers for the leadership they will eventually assume, Cornell University will require five years instead of the conventional four for a bachelor's degree in all branches of engineering after the war. The developments of science demand a sound technical training. Any reduction in this area would weaken a graduate's knowledge for carrying forward the advances of science. Various studies made by those interested in the engineering profession have always indicated the need for broader training. By taking more time the program can achieve this objective. For a bachelor's degree under the five-year curricula, 180 credit hours will be required, of which not less than 125 will be given to scientific and technical courses, and not less than 36 to managerial and non-technical courses. Opportunity is thus afforded students to acquire a better knowledge of economics, English, history, philosophy, government, sociology and other liberal subjects. The non-technical subjects will be arranged in sequential order throughout the five years, running parallel with the technical studies. Those who have been impressed by the concentration of technical education in war-time will not like this announcement. But it will probably take many ex-service men a long time to discover that what they have had is technical training, not engineering education. And the function of the engineering college is merely to start the neophyte on the engineering road, pointing the way he should go. The engineering education itself will take the neophyte all the rest of his life and he must give it to himself. To give him some indication of what he must do to himself if he is to become an engineer, five years in college, in our opinion is not too long. We do think, however, that by proper aptitude testing and applying some of Dr. Robert M. Hutchins' ideas, the young man could be started into engineering earlier and with less waste motion in the preparatory schools.

WHEN THE TALK turns to the possibility of the individual private plane for post-war and all the possibilities it opens up, do you ever let yourself go and wonder if anybody has investigated the possibilities of the lighter-than-air craft, the dirigible, for an individual and family aircraft? One of the principal problems of the airplane is take-off and landing space. The helicopter is offered as the solution for this. But suppose a small four or six-passenger dirigible could be built using aluminum and magnesium alloy, of which there will be a superabundance, for the skin, instead of fabric, and some non-inflammable gas—helium? or something the synthetic chemists might develop?—for the lifting medium. It might offer all the advantages of low landing and maneuvering speeds plus a cruising speed of 75 to 80 mph. Already one of the pioneer builders of large dirigibles is beginning to ask if they are not worth reviving for freight-carrying purposes. Why not look into the idea for the flivver domestic aircraft of the future? It might be a way to use our tremendous capacity for producing aluminum and magnesium. Well, we can dream, can't we? Everybody else is doing it.

PROPER SHARPENING of Carbide Tools is discussed in a well-illustrated article by E. T. Larson in Vol. 35, No. 4 of Grits and Grinds, published by Norton Co.

GERMAN PRISONERS OF WAR who are helping to build a relief map precision scale model of the entire Mississippi watershed for the U. S. Army engineers may be getting quite a kick out of it. These men of the master race are doubtless thinking that we are fools for allowing them to get so much information about our plans to take back to Germany with them after this war and use in starting the next one. Perhaps we are fools, or perhaps the Army isn't giving them any more information than needed to dig a hole here or there. At any rate, the colossal relief map, 4500 ft from Montana to North Carolina, will provide a visual means of studying the many related problems involved in operating the reservoirs now built or planned in the Mississippi watershed, involving hydraulic works costing 1½ billion dollars. We have always maintained, as have many other engineers, that the way to control Ol' Man River was by the proved method of controlling the entire watershed as a unit, with proper co-ordination of power, irrigation, flood control and all other factors, instead of continuing the building of levees and dikes that seem to do little good. We hope this time the Army engineers will be able to get somewhere with the idea.

A "FRIGIDAIRE" MUSEUM has recently been designed by Professor M. Sumgin, a Russian scientist, to be built deep underground in Northern Siberia, where the land is perpetually frozen. By placing in it bodies of humans and animals, together with samples of all the equipment and activities of man, a picture of life could be built up over any desired span of years, 100 or 1000 or 10,000, that would be of great value to future historians and scientists. The reason for this is that the extremely low temperatures of the earth's crust at this point would preserve animal tissue under natural refrigeration for very long periods. The crust never thaws more than 6 ft below the surface. Below that is a crust of perpetual frost ranging to a depth of about 1000 ft and within this crust have been found well-preserved bodies of prehistoric animals as well as more recent human bodies. One body recently discovered was buried in the 17th century. Not only was the body well preserved but the wood of its coffin, also a saddle, cooking utensils, and even food buried with the body, had not deteriorated. The Time Capsule may have some competition, if this one goes through.

A USEFUL POSTWAR DEVICE which has come as a result of war development is a 500 lb mobile tire vulcanizing outfit. In this device internal heating of the vulcanizing patch is accomplished by means of a high frequency generator. In combat zones major tire repairs are made in ten minutes instead of the former time of several hours, says Ohmite News.

THE GOOD OLD CULTURAL LAG in operation: every so often some publicity man (usually a former "journalist") discovers that water-injection is being used in airplane internal combustion engines and sends out a big publicity story that he thinks should make editors and readers swoon like Sinatra's bobby-soxers. What's new about water-injection? It has been tried for years with all kinds of combustion equipment, including even boiler furnaces. It's like everybody discovering electronics after it has been developed and in use for 25 yr or the theory of relativity 20 yr after Einstein enunciated it.

IN THE FAR-AWAY days of our youth, almost every New England farmer had tucked away in a trunk in his attic a bundle of beautifully-engraved stock certificates in one or more companies formed to extract gold from sea water. The promoters of these stocks, however, seldom bothered to explain what proportion of gold there was in sea water nor how it was going to be recovered. We know today that the bromine and magnesium that are being recovered from sea water on a commercial scale are worth far more to us than gold. It should come as no surprise, therefore, that coal contains many of the rare and uncommon elements. For many years, these have been studied by scientists and there is an extensive literature on the subject. Elements like gallium, germanium, radium, silver, titanium, uranium, and many others are found in various amounts in coal or its ash, usually in very small amounts. These are discussed in detail in a recent Technical Paper No. 669 entitled, Rare and Uncommon Chemical Elements in Coal, by F. H. Gibson and W. A. Selvig, published by the Bureau of Mines, U. S. Department of the Interior. A copy can be obtained for 10 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

HANDBOOK of Standards for Describing Surplus Property when listed in Inventory Reports has recently been prepared and published for the Surplus War Property Administration by the War Production Board. Copies are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., at 10 cents each. The handbook covers: Section I, Metals and Metal Basic Products; Section II, Wood Basic and Finished Products.

FOR THE U.S.S.R. Dnieprostroi hydroelectric plant, International General Electric will supply nine 90,000-kva generators. These units, already in construction by G. E. at Schenectady, will give the famous plant a 15 per cent greater output capacity than it had originally. The new generators will replace those partially destroyed by the Russians when they retreated before the Germans in 1941. The original generators for the plant, which was completed in 1933, were rated 77,500 kva and 88.2 rpm. The new 90,000-kva units will operate at 83.3 rpm. This decrease in speed, coupled with the increase in kva, results in an equivalent increase in size of 21 per cent. They will be the largest generators in diameter and total weight ever built. Hydraulic turbines for the station are being built by the Newport News Shipbuilding and Dry Dock Co. Each waterwheel will be capable of developing 100,000 hp. Financing of the machines will be by the Soviet Union and not by lend-lease, according to an announcement by the War Production Board. The WPB announcement also stated that no fixed delivery date would be promised for the machines and "manufacture would not be allowed to interfere with the production of war supplies or equipment needed for essential civilian production."

POCKET-SIZE CLOUDS and snowstorms that would fit into your hat are "manufactured" at the Westinghouse Research Laboratories to help speed development of more powerful electrical systems for American warplanes. Confined in a glass flask not much bigger than a milk bottle, the clouds and the snowflakes that flutter down from them are used to test the effectiveness of electrical insulation at altitudes up to 12 miles. A thick cloud can be created in a few seconds by pouring liquid air into warm water and snow can be made to fall by cooling the flask below the freezing point.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15 Minutes a Day—How to Tube a Heat Exchanger for New High Temperatures, New High Pressures; Mechanical Topics, Vol. 7, No. 4; International Nickel Co., Inc. * * * Fifteen Years' Experience with Handicapped Employees; Executives Service Bulletin, Oct., 1944; Metropolitan Life Insurance Co. * * * Horsepower Ratings for Oak Tanned Flat Leather Belting; The Blackmer Swinging Vane, Sept.-Oct., 1944; The Blackmer Pump Co. * * * Protect Your Motors from Invasion, describing in detail methods of enclosure and prevention of dirt, ventilation, sparking troubles; "Dog Tags" for Industry's Product Army, a discussion of trade marks; both beautifully illustrated; Electrical Review, Sept., 1944; Allis-Chalmers Mfg. Co. * * * Reconversion in the Laboratory; also a biography of Theodore William Richards, one of the greatest of our American scientists; Anco News Chats, No. 46; Central Scientific Co. * * * Venice, Nation's Newest Steam Plant, Tops Its Two Billionth KWHR, showing how its operation near capacity enabled system to meet war demands; Union Electric News, Oct., 1944; Union Electric Co. * * * The Norton Bura-way, a tool grinder using new principles in single-point cutting tool grinding and design, well illustrated; Grits and Grinds, Vol. 35, No. 8; Norton Co. * * * From Algebra to Steel Plant, interesting story of how a teacher made the jump; Steel for Victory, Oct., 1944; American Iron & Steel Institute * * * Rural Electrification After the War, detailed outline of projected 5½ billion dollar program to extend electric service to over 3½ million new customers; Rural Electrification News, Nov., 1944; Rural Electrification Administration. * * * Designed for Living, the influence of plastics on postwar furniture; Salvage of Porous Castings; Clear Signs for Victory, showing uses of plastics for military signs and instrument panels; all beautifully illustrated; Bakelite Review, Oct. 1944; Bakelite Corp. * * * "Doll House" Models Engineer Post-War Plants; Wesco Reporter Nov., 1944; Westinghouse Electric & Mfg. Co. * * * An Engine a Day for a Liberty Ship, details and illustrations of how they were built; Compressed Air Magazine, Nov., 1944 * * * Directory of House Organs, listing 5100 company magazines by titles and sponsors, just published by Printers' Ink, 205 East 42nd St., New York 17, N. Y., price $2.50.

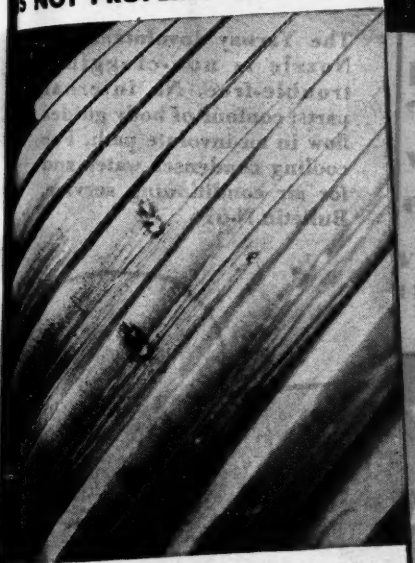
A JET PROPULSION ENGINE for robot bombs is being produced by the Ford Motor Co. At the request of the Air Technical Service Command at Wright Field, Ohio, Ford engineers worked out production engineering details following reconstruction of a German robot engine from parts shipped from England. Ford-made engines already are powering robot bombs of American make being used for testing purposes.

COLOR can be applied to steel, copper, brass, bronze, zinc, nickel, tin, gold, silver, aluminum, magnesium and other metals and alloys, by simple processes of chemical immersion. A long range of colors is possible in iridescent and matte effects. Many of the coloring baths also increase the corrosion resistance of the metal being treated. Coloring salts or solutions are furnished, with instructions for their use, by the proponents of the process, Colonial Alloy Co. Metal preparation and cleaning instructions are also given. For those interested it is suggested that samples of the metal-to-be-colored be submitted, together with a sample or description of color desired. A description of the end-use of the product is also desirable (outdoor or indoor use, type of service, etc.). Instead of sending samples of solutions for test customers' specimens will be colored and returned.

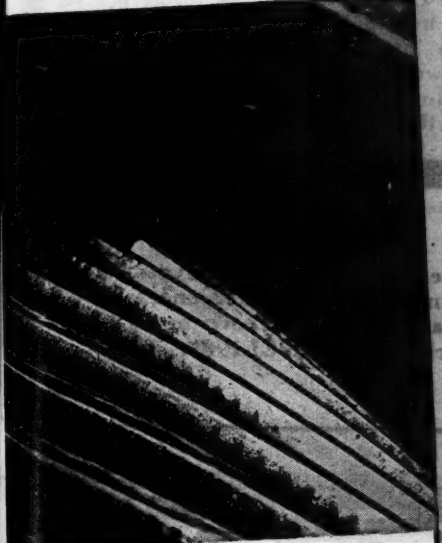
Don't send good turbine oil after bad—

CLEAN DIRTY OIL SYSTEMS!

HERE'S WHAT HAPPENS TO TURBINE GEARS WHEN SYSTEM IS NOT PROPERLY CLEANED



Scoring of the gears, above, was caused by metal chips left by insufficient cleaning at the time of initial installation.



Because of improper cleaning methods, the oil in this system broke down completely after only six months of operation. Note severe wear on the gears caused by abrasive contaminants.

The New SHELL CLEANING PROCEDURE makes it easy...more efficient

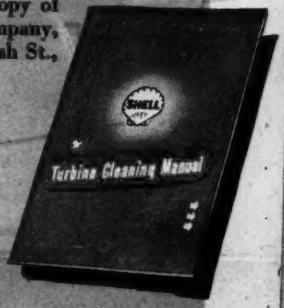
IT HAS BEEN PROVED that the presence of a small amount of used turbine oil in a new fill may reduce the life of the new charge by as much as 50%! In addition, contaminants can cause excessive wear, improper operation of the governor, affect seriously the flow of oil to vital parts, interfere with the efficient transfer of heat in bearings and oil coolers.

Not only should *dirty* oil systems be cleaned, but the cleaning of *new* equipment is also necessary. In a new turbine, materials such as loose mill scale, metal chips, core sand, gasket compound, slushing compound, run-in oil and any rust that may have formed during the erection of the turbine, must be removed. They *can* be removed, and effectively, by new, Shell Turbo Cleaner, using Shell's Turbine Cleaning Procedure.

Before you add that next batch of oil to your system, be sure to get the details on Shell Turbo Cleaner and Shell's Cleaning Procedure. See your Shell man or send for your copy of the Turbine Cleaning Manual. Address: Shell Oil Company, Inc., 50 W. 50th St., New York 20, N. Y., or 100 Bush St., San Francisco 6, Calif.

SHELL

SEND FOR THIS BOOKLET NOW! Every turbine owner and operator should have a copy. It contains full details on the new Shell Turbo Cleaner and the Shell Turbine Cleaning Procedure. Shows you how simple and easy it is to keep your turbines clean...operating at peak efficiency.



SHELL TURBO OIL

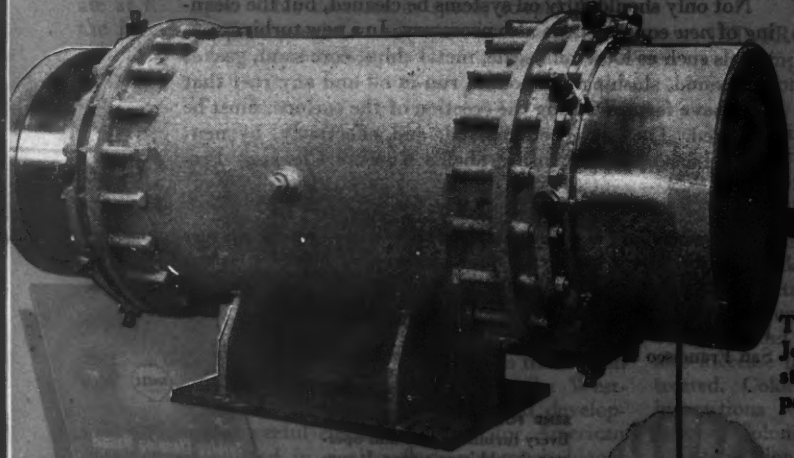
THERE'S

"IMPULSE"

The Yarway Impulse Steam Trap has only one moving part; no buckets, bellows, levers or floats. Bulletin T-1739.

"INVOLUTE"

The Yarway Involute Spray Nozzle is non-clogging, trouble-free. No internal parts; contour of body guides flow in an involute path. For cooling condenser water and for air conditioning service. Bulletin N-616.



"GUN-PAKT"

The Yarway Gun-Pakt Expansion Joint may be re-packed under full steam pressure and never needs unpacking. Bulletin EJ-1909.

YARWAY

A Reason..

ALL these Yarway Steam Specialties have become outstanding successes because of unique Yarway engineering principles. That's why so many plant operators say, "Yarway is our way" when selecting such equipment.

YARNALL-WARING COMPANY
114 Mermaid Ave. Phila. 18, Pa.

"FLOATLESS"

The Yarway Floatless Water Column operates with balanced solid weights, on the well-known displacement principle. Bulletin WG-1809.

"SEATLESS"

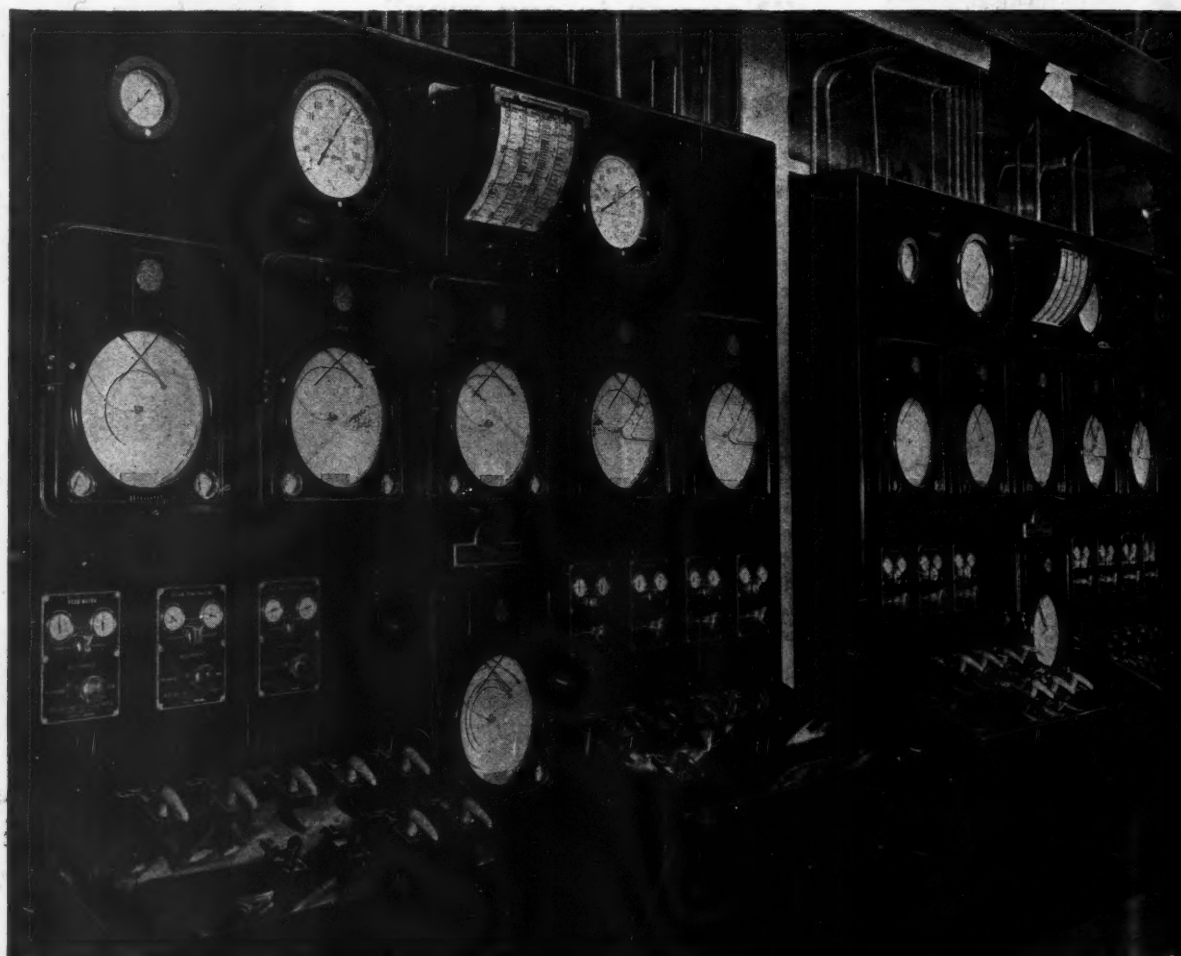
The Yarway Seatless Blow-Off Valve has no seat to score, wear and clog with mud, scale and dirt. Write for Catalog Section B-424 for pressures to 400 lb, Section B-431 for pressures from 400 to 2500 lb.

STEAM SPECIALTIES

MORE THAN

AND

Bailey Boiler Control Panels for two 135,000 lb. per hour capacity, oil and gas-fired boilers in a Western Power Station



BAILEY METER CONTROL

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHE

METERS

CONTROLLERS

A Bailey Boiler Control System is more than just a group of meters and controllers recording and controlling certain factors in the boiler plant. It is a means of improving plant operation from the standpoints of:—

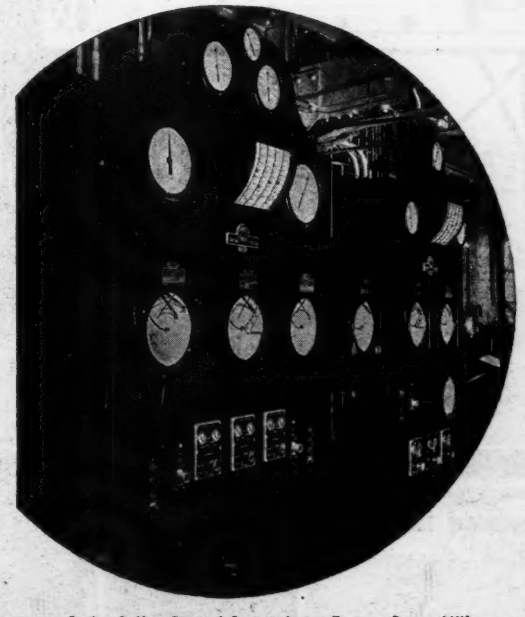
1. Continuity of service **3. Steaming capacity** **5. Safety**
2. Fuel conservation **4. Conservation of manpower**

Bailey Control Systems are effective because each system is carefully engineered to the requirements of the unit which it serves. The experience gained from thousands of successful combustion control installations serves as a basis for this engineering service which starts with the selection of equipment and continues through the design, construction, calibration, installation and final adjustment on the job.

Engineering work is done in the user's plant by Bailey Field Engineers who have been thoroughly trained in combustion and automatic control practice. These engineers are stationed in over 30 industrial areas throughout the United States and Canada for the purpose of rendering prompt "on the spot" engineering service without undue traveling expense.

The Bailey engineer in your community has a wide background of combustion engineering know-how at his command. It includes the records of tests on thousands of boiler installations covering a wide range of fuels, furnaces and fuel-burning equipment. He has more to offer than meters and controllers. He is primarily interested in helping you to secure optimum operating conditions in your plant. G-19

Bailey Boiler Control Panel for 100,000 lb. per hour capacity Integral-Furnace Boiler



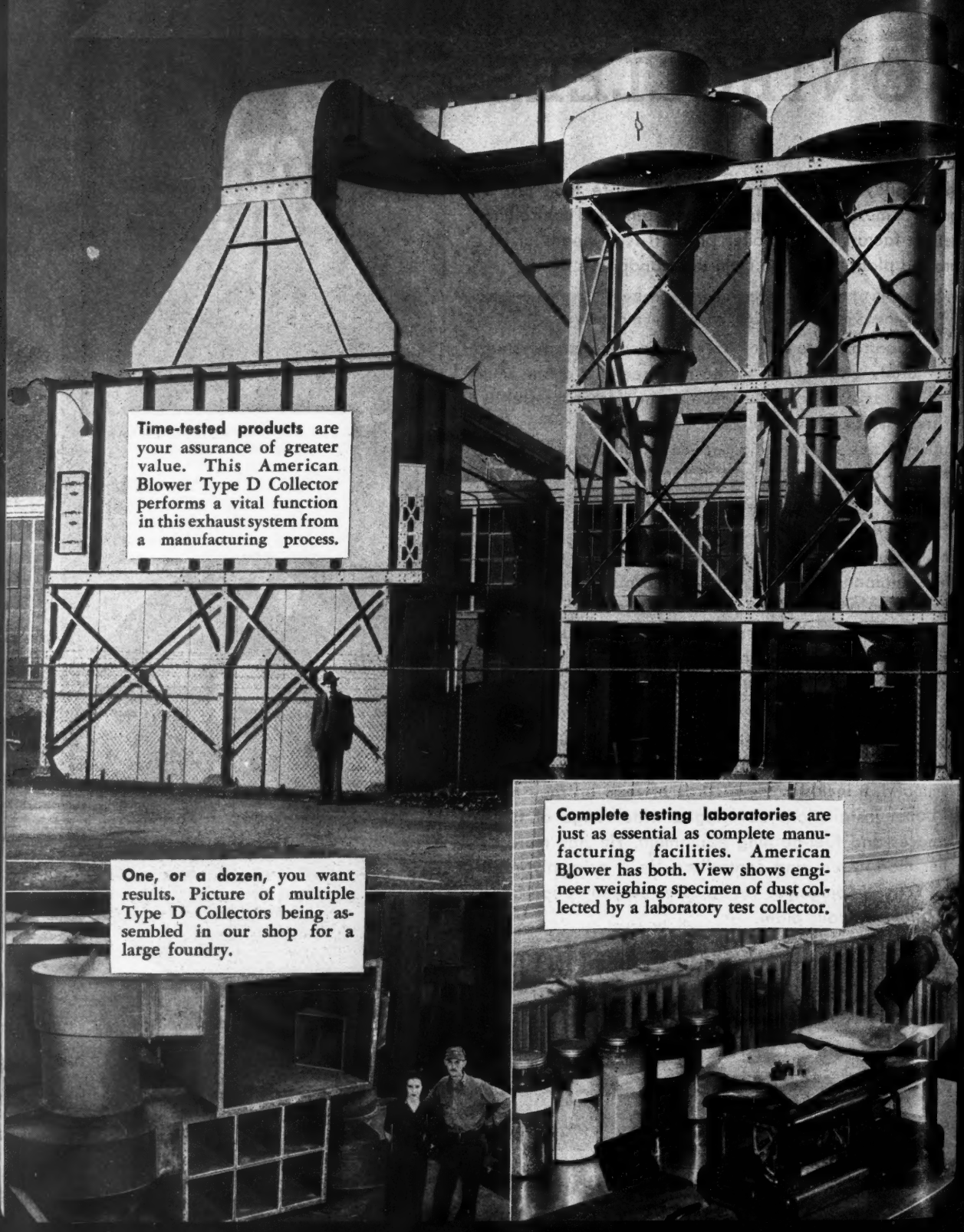
Bailey Boiler Control System in an Eastern Paper Mill

BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND 10, OHIO
Bailey Meter Company Limited, Montreal, Canada

The Complete Combustion Control System

NTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

American Blower



Time-tested products are your assurance of greater value. This American Blower Type D Collector performs a vital function in this exhaust system from a manufacturing process.

One, or a dozen, you want results. Picture of multiple Type D Collectors being assembled in our shop for a large foundry.

Complete testing laboratories are just as essential as complete manufacturing facilities. American Blower has both. View shows engineer weighing specimen of dust collected by a laboratory test collector.

Dust Collectors

Dust collecting is no longer in the trial and error age.

Complete testing laboratories, and a background of years of experience in designing and building dust collectors to meet hundreds of different problems, are available to you at American Blower.

In the last 20 years, alone, we have carried out tests of over 4100 distinctly different materials. As a result, American Blower Dust Collectors are giving highly satisfactory results in a wide variety of industries and process work.

You can profit by our wide experience and complete facilities. Investigate now. Call the nearest American Blower Branch Office, or write direct to the factory. Ask about the data in our "dust library"—the most comprehensive case history of various dusts in the world.

Your inquiry will not obligate you or your organization in any way.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary corporation

Unexcelled facilities for manufacture are found in American Blower plants, and every collector is a custom-built job. Photo shows sections of Type D Collectors for heavy duty in a cement plant.

REASON NO. 4

FOR USING

GEARMOTORS

5%

GEARMOTORS REDUCE LOSSES

IN POWER TRANSMISSION

Gearmotors cut power transmission losses to the very minimum. So efficient is a gearmotor in transmitting power that not more than a 2% loss is involved in each gear set. This means that in its gearing parts a single-reduction unit is 98% efficient . . . a double-reduction gearmotor 96% efficient. Contrast this performance with the 60% to 75% power transmission efficiency of some other types of drives.

Here's a typical example of how gearmotors can cut power losses: On a flying shear application a 5 hp gearmotor was installed to replace the belt drive previously used. Result—power costs were decreased 10%, production increased 16%.

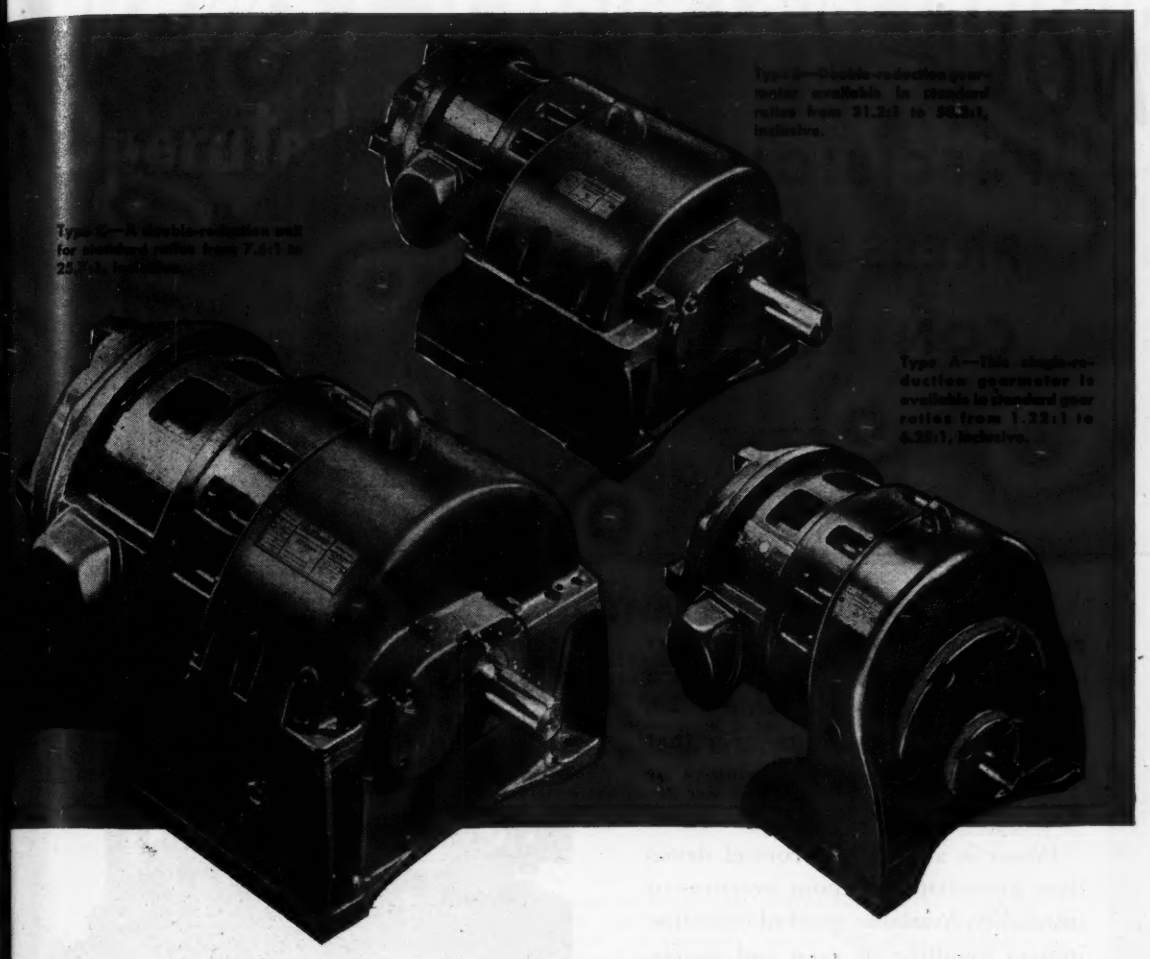
Less power loss in transmission assures *more* power for *production!* Ask your Westinghouse representative about this and the many other basic advantages of gearmotors. All of these are discussed in detail in the new gearmotor handbook, "Gearmotor Applications". Ask for B-3218. Westinghouse Electric & Manufacturing Company, P.O. Box 868, Pittsburgh 30, Pa. J-07224

REASON NO. 1—GEARMOTORS SAVE SPACE
REASON NO. 2—GEARMOTORS SIMPLIFY SELECTION, ORDERING, DELIVERY
REASON NO. 3—GEARMOTORS SAVE INSTALLATION TIME AND EXPENSE

One of a series sponsored by Westinghouse to promote the use of gearmotors

WESTINGHOUSE

Westinghouse



10 CHECKING POINTS

WHICH EXPLAIN THE ADVANTAGES OF WESTINGHOUSE GEARMOTORS

. **FEWER PARTS TO WEAR.** The simple, efficient esign employs a minimum of moving parts.

. **BPT "TOUGH-HARD" GEARS AND PINIONS.** his exclusive Westinghouse heat-treating method tough-hardens" teeth for maximum resistance to ock and impact—means longer wear.

. **USE ALL WESTINGHOUSE MOTOR TYPES** open . totally-enclosed . . . splashproof . . . explosionproof to meet changes in operating conditions quickly d easily.

4. INTERCHANGEABILITY OF PARTS between unit types reduces your parts replacement stock by 40%.

5. HIGH EFFICIENCY of gearing parts assures full motor horsepower at output shaft . . . only 2% power loss for each gear set.

6. POSITIVE LUBRICATION of gears and bearings by automatic splash system reduces probable maintenance to twice-a-year change of oil.

7. EASY ACCESSIBILITY. Gearing parts can be readily inspected or easily removed to make gear ratio changes.

8. IMPROVED FOUNDATION STABILITY. Feet are under the gear case . . . placing support next to the gearmotor load. Each foot is reinforced by external ribs.

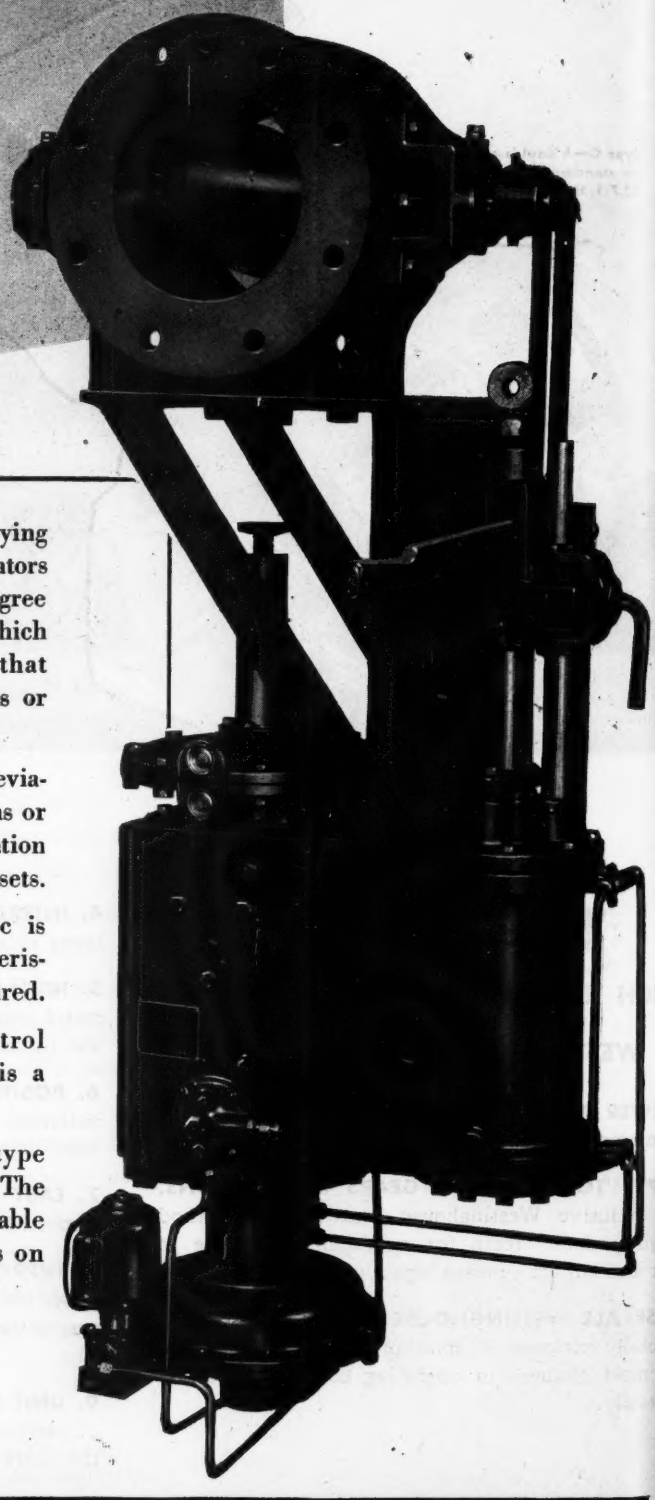
9. UNIT RESPONSIBILITY for design . . . manufacture . . . and service. Westinghouse builds both motor and the gears.

10. MEET A. G. M. A. STANDARDS. Westinghouse Gearmotors are specifically designed and built to meet A.G.M.A. standards . . . easy to order and match to the job.

Gearmotors

NOW—

PRECISION PRESSURE CONTROL



● Republic regulators, employing pneumatic or hydraulic piston operators as the power elements, offer a degree of precison in pressure control which is a considerable advance over that obtained from ordinary regulators or controllers.

Power is available to correct deviations immediately without overruns or instability. Available speed of operation insures handling of even bad upsets.

The basic control characteristic is floating, with proportional characteristic easily added in the field if required.

Remote setting from the control board by a pneumatic loader is a standard feature.

Valve bodies may be of any type required by operating conditions. The butterfly valve illustrated is suitable for many back pressure services on close fractionation.

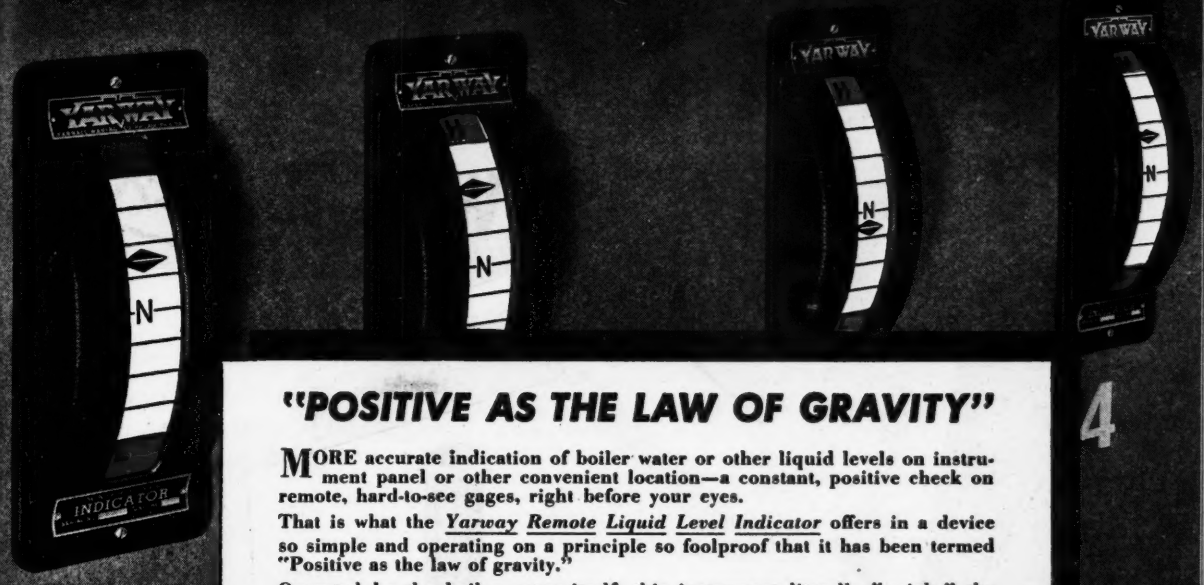
Write for complete data!

Pneumatic loader for remote hand setting.

REPUBLIC FLOW METERS CO.

2224 Diversey Parkway, Chicago, Illinois

NEWS! A Water Level Indicator Operated by the Boiler Water Itself



"POSITIVE AS THE LAW OF GRAVITY"

MORE accurate indication of boiler water or other liquid levels on instrument panel or other convenient location—a constant, positive check on remote, hard-to-see gages, right before your eyes.

That is what the *Yarway Remote Liquid Level Indicator* offers in a device so simple and operating on a principle so foolproof that it has been termed "Positive as the law of gravity."

Operated by the boiler water itself, this instrument literally "weighs" the difference between a constant column of water and the varying level in the boiler drum and indicates this difference, continually, by pointer movement over a calibrated scale.

That's all there is to it.

Extreme accuracy and instant indication are assured because the instrument is frictionless. There are no stuffing boxes. Operates by means of a unique, powerful, permanent magnet transmission between actuating mechanism, under pressure, and indicating mechanism, at atmosphere.

Hundreds of Yarway Remote Liquid Level Indicators in service throughout Industry and the Yarway Steam Laboratory's own accelerated endurance test (duplicating over 50 years of normal boiler service) have proved the dependability of this instrument beyond question.

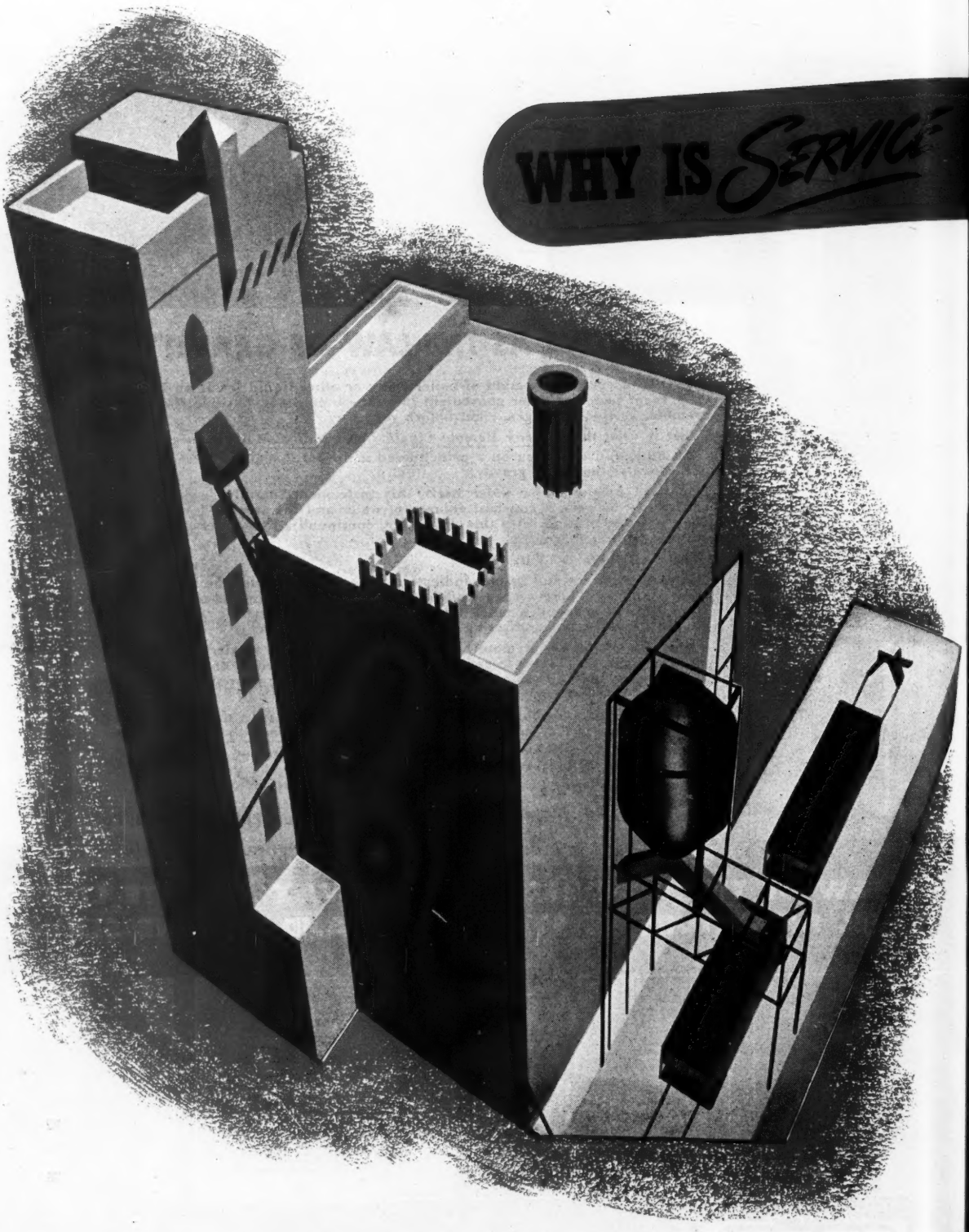
Satisfied that it more than meets exacting Yarway Standards, this instrument is now offerod to the general public. Look into this *moderately priced* instrument which is easily installed on new or existing boilers and is suitable for all pressures up to 1500 lbs.

Write for Bulletin WG-1820.

YARNALL-WARING COMPANY, 114 Mermaid Avenue, Philadelphia 18, Pa.

A FEW OF THE HUNDREDS OF YARWAY REMOTE LIQUID LEVEL INDICATORS IN STATIONARY AND MARINE SERVICE

YARWAY REMOTE LIQUID LEVEL INDICATOR


WHY IS SERVIC

MPORTANT TO STOKER OPERATION?

SINCE a stoker constantly works under heavy operating conditions, it requires some attention and replacement of parts from time to time.

To render good, quick service—especially in emergencies—the American Engineering Company maintains four substantial stocks of replacement parts in strategically located service stations.

Each service station is headed by a manager who has had extensive experience in meeting the diversified conditions of proper service.

To be of further help to you, A-E-CO has a staff of skilled service engineers in the field. These engineers make periodic visits to Taylor installations to check equipment and assist the plant in achieving greater operating economy.

Taylor Stoker Service Engineers are also available at a reasonable charge for customers requiring service beyond the scope of the periodic check up and inspection.

Good service is another plus value in Taylor Stoker's efficient, low cost generation of steam.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. RELIABILITY—the ability to operate with minimum outage and minimum standby equipment.

2. CAPACITY—the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.

3. MAINTENANCE—the ability to operate continuously with minimum repair costs.

4. FLEXIBILITY—the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.

5. EFFICIENCY—the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.

6. OPERATION—the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.

7. ADAPTABILITY—the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.

8. FUEL FLEXIBILITY—the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.

9. REFUSE DISPOSAL—the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.

10. STACK DISCHARGE—the practical elimination of "smoke nuisance" without special equipment.

11. SPACE REQUIREMENTS—the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.

12. OBSOLESCENCE—the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

A-E-CO TAYLOR STOKERS • LO-HED HOISTS
HELE-SHAW FLUID POWER • MARINE DECK AUXILIARIES

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25 • PENNSYLVANIA

Let's Get Down to FUNDAMENTALS

PATERNAL ANCESTOR

ONCE UPON A TIME there was a little Steam Trap that ventured forth into Topsy Turvey land to find a place to live. But when he got there, other steam traps told him, "You'll never do here. You have too many moving parts. Your fittings are all wrong. You are too simple. And besides that, your ears are too long!"

Perplexed, the little Steam Trap returned from Topsy Turvey land and went direct to Great-great-great-grandad Steam Trap. "Sire," said he, addressing the venerable one, "Aspersions have been cast upon my ability to whistle like a peanut vendor's wagon. Pray please tell me again: just what is it that I'm supposed to do?"

Here is what the old boy told him:

I

A TRAP MUST DISCHARGE WATER

a. The orifice should be large enough to take care of peak loads easily regardless of the operating pressure.

b. The trap should be able to handle condensate at any temperature—cold, warm, or at steam temperature.

c. Actual condensate capacity ratings are necessary. Calculated capacities or cold water tests are of no value. Armstrong's capacity table shows what Armstrong traps will handle when the condensate is at steam temperature.

BEWARE OF CAPACITY RATINGS

II

TRAPS SHOULD PREVENT LOSS OF STEAM

a. When the Armstrong bucket is 2/3 full of steam it floats and closes the valve.

MAKING PERFECT CONTACT WITH SEAT

b. The Armstrong valve will close tight in any position because it is a perfect hemisphere and always makes a perfect contact with its seat.

c. The Armstrong valve will continue to make perfect closure because both valve and seat are made from heat-treated chrome steel that is very hard and tough.

d. The Armstrong Trap does not require adjustment in order to function properly.

e. The Armstrong Trap will discharge condensate to, but hold steam against, the highest vacuum obtainable.

III

A TRAP SHOULD BE ABLE TO DISCHARGE AIR

a. In the Armstrong Trap, air escapes through the vent in the inverted bucket. This vent is always open to handle air at any temperature.

VENT OPEN

b. Large vents, thermostatically controlled, can be furnished for Armstrong Traps to drain jacketed kettles, syphon-drained rolls, etc. These large air vents can be adjusted to close at any required temperature.

THE ARMSTRONG TRAP PRIMER

IV

A TRAP SHOULD BE ABLE TO OPERATE UNDER BAD WATER CONDITIONS

a. Any oil present with the condensate will rise to the top of the Armstrong trap body and be discharged first.

b. There are no dead spots in the Armstrong trap body in which dirt or sludge can settle.

DEAD SPOTS

c. All parts in an Armstrong Trap are made of stainless steel which resists corrosive liquids.

V

A TRAP SHOULD REQUIRE LITTLE MAINTENANCE

a. The Armstrong Trap has only two moving parts —the bucket and the lever assembly. There are no pivots or cotter keys.

FRICTION-LESS OPERATION

b. Frictionless operation insures long life of parts in an Armstrong Trap. There are no sliding contacts or variable clearances to affect the power of the bucket to open the valve.

c. The Armstrong valve opens wide and closes tight. This prevents wire-drawing and scoring of valve.

d. There are no parts that can be damaged by excessive pressure.

VI

A TRAP SHOULD BE EASY TO USE

a. The Armstrong Trap is light in weight and small in size—particularly on the basis of capacity.

b. The position of connections fits in well with standard practice and permits simple installations regardless of what the requirements may be.

c. Each trap is equipped with a handy test plug over the discharge orifice.

TEST PLUG

d. Care is taken to prepare literature that answers every possible question a user might have about the application or installation of Armstrong traps.

VII

A TRAP SHOULD HAVE RESPONSIBLE BACKING

a. The success of the Armstrong organization depends entirely on the performance of the Armstrong Trap. Under such circumstances, it is only natural that great care is excercised to make sure that every customer is satisfied and that every claim is fulfilled.

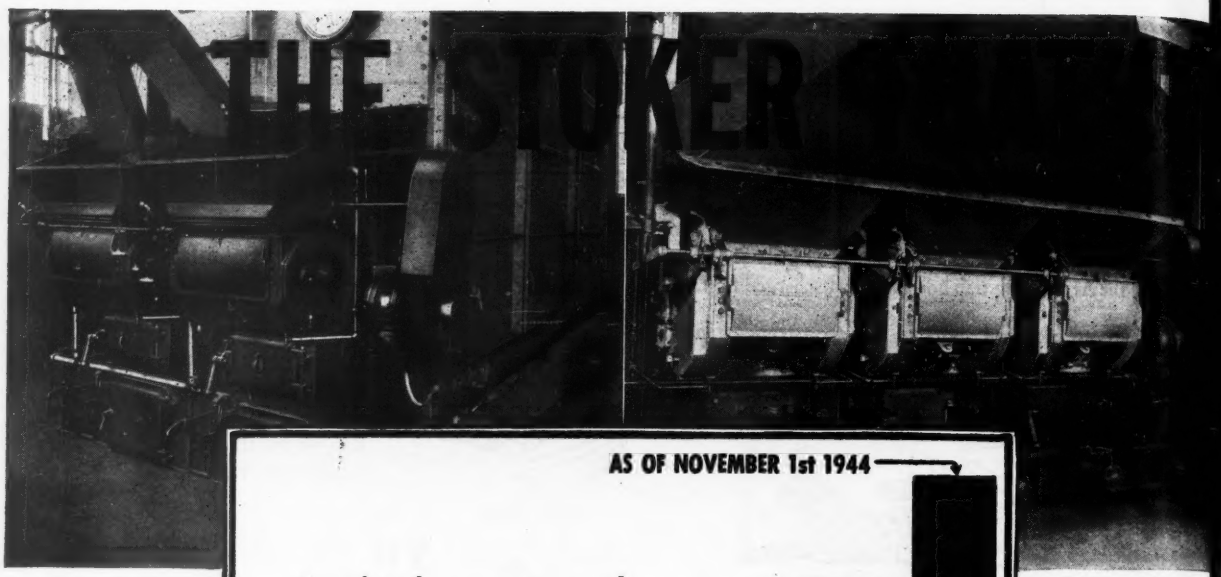
EXERCISING CARE

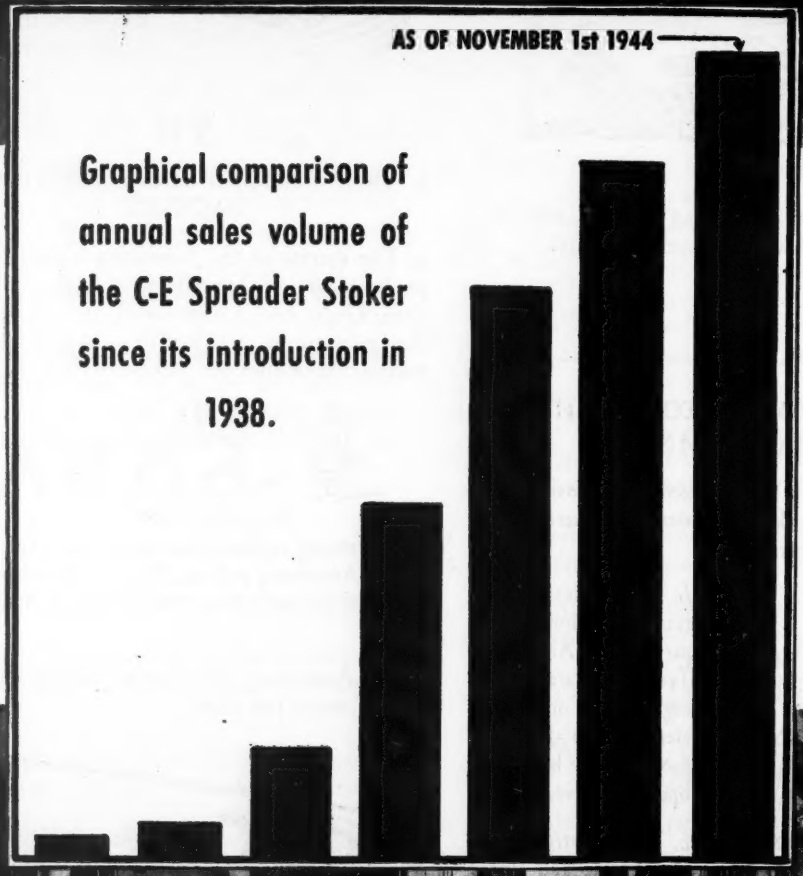
b. Armstrong representatives subscribe whole-heartedly to Armstrong policies. Many of them have built their business entirely on the success of Armstrong Traps.

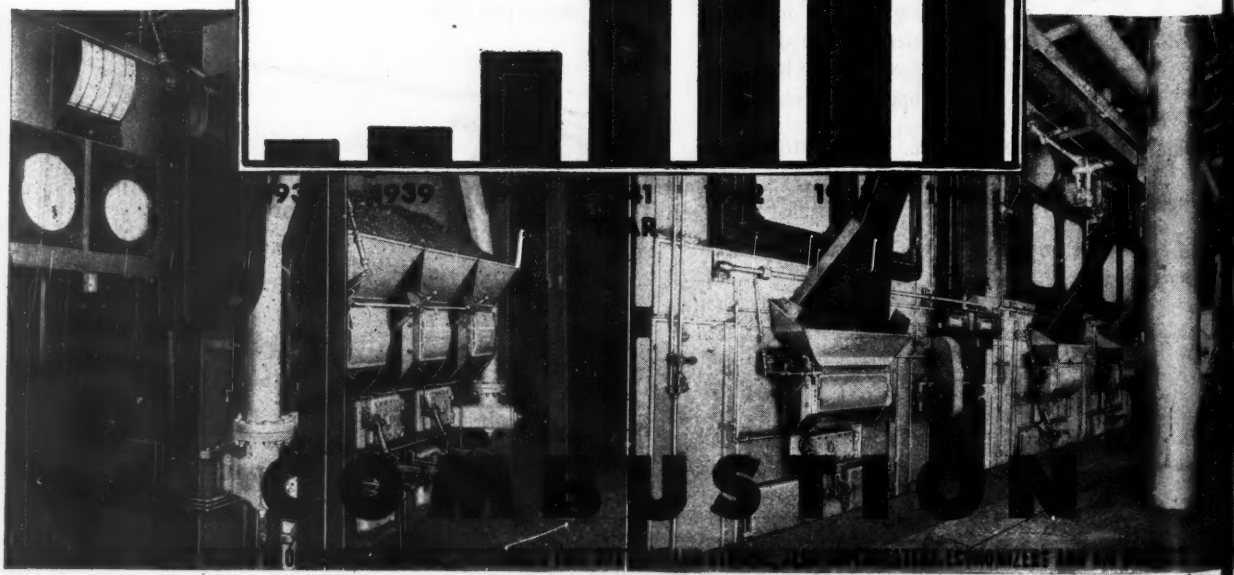
c. The Armstrong guarantee of "Complete Satisfaction" means just that!

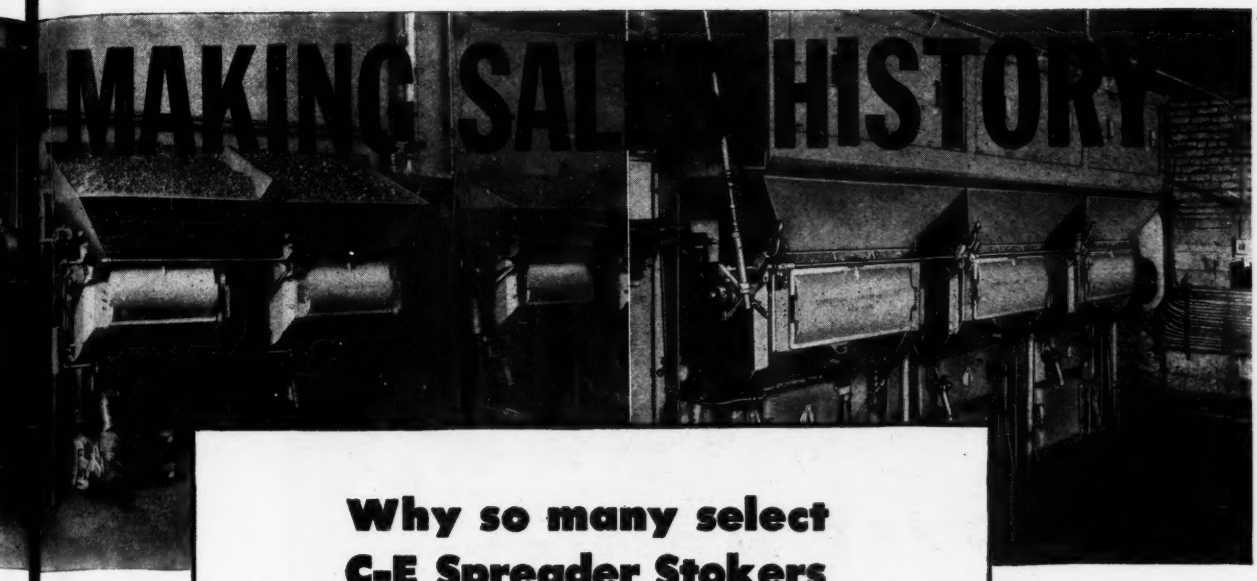
P.S. Points listed here are discussed in detail in the new Armstrong Steam Trap Book. If you would like to read this book, drop us a line and we will send you a copy.

ARMSTRONG MACHINE WORKS
Three Rivers, Michigan
810 Maple Street


THE STOKER


AS OF NOVEMBER 1st 1944
Graphical comparison of annual sales volume of the C-E Spreader Stoker since its introduction in 1938.


1939
COMBUSTION



Why so many select C-E Spreader Stokers

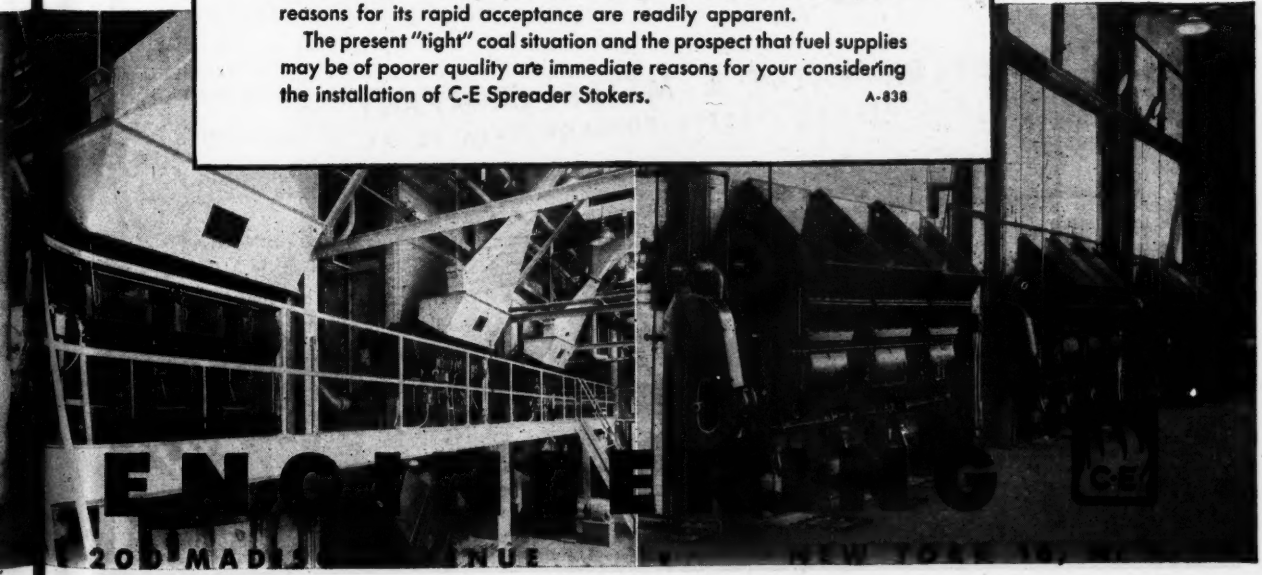
The graph on the opposite page depicts the swiftly mounting sales of C-E Spreader Stokers and reflects the widespread acceptance of this advancement in economical coal firing.

This stoker, because of the design of its grate surface, feeding mechanism and air distribution, assures a thin, uniform fuel bed favorable to the burning of a wide variety of fuels — from eastern bituminous to low grade Russian sub-bituminous.

High ash, high volatile, eastern or mid-western bituminous, sub-bituminous, lignites — all are burned satisfactorily and efficiently by the C-E Spreader Stoker. Coals with a relatively high percentage of fines are no problem, for the fines are burned in suspension and the larger particles on the grate — literally combining the advantages of pulverized coal and stoker firing. Thus the limitations of premium priced, selected coals are removed and the range of available coals is tremendously broadened.

The C-E Spreader Stoker responds promptly to load variations and is adaptable to limited space conditions. Add to this its low maintenance and easy operation through automatic control, and the reasons for its rapid acceptance are readily apparent.

The present "tight" coal situation and the prospect that fuel supplies may be of poorer quality are immediate reasons for your considering the installation of C-E Spreader Stokers. A-838



HERE ARE ALL THE FACTS ABOUT THE

SIMPLEX TYPE MO METER

The High-Accuracy Flow Rate Meter

Write today for your copy of Bulletin 300 which details the operation, use, specifications, and accuracy of the Simplex MO flow rate meter. Specified by operating men and management from coast to coast.

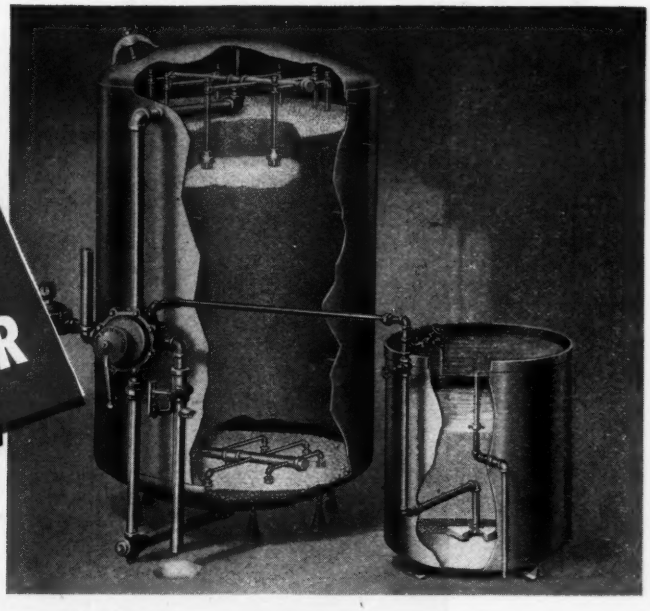
SIMPLEX VALVE & METER COMPANY

6783 UPLAND STREET, PHILADELPHIA 42, PA.

NOW AVAILABLE

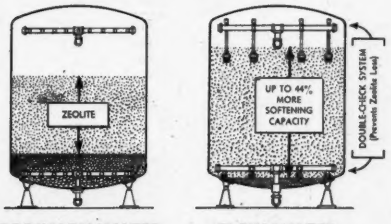
postwar design

ELGIN WATER SOFTENER



. . . delivers up to 44% more soft water

NOTE THE INCREASED CAPACITY



ORDINARY WATER SOFTENER DESIGN

ELGIN WATER SOFTENER DESIGN

HERE'S HOW TO STEP UP THE OUTPUT OF YOUR PRESENT WATER SOFTENER

The "Double-Check" equipment can be installed in place of the present manifold in your zeolite softener regardless of make. This change, along with Elgin High Capacity Zeolite, will give you greatly increased soft water output. The cost of this modernization is surprisingly low. Let us give you facts.

• Here's real news for users of zeolite water softener equipment. Our postwar design is now available. It delivers up to 44% more soft water than any other unit of equal size. Of importance is the fact that this new water softener has been fully proved by gratifying results in a long list of plants where it is already in service.

An improved double-check type manifold prevents the escape of zeolite and therefore permits placing a far greater amount of water softening zeolite in the softener, as shown. More zeolite means more soft water output—for it's the zeolite that does the softening.

But that isn't all. A higher backwashing rate is also made possible by preventing loss of zeolite. This higher rate cleans the softener thoroughly. With the zeolite bed clean, the salt reaches every grain of zeolite. The result is better regeneration with less salt consumption . . . higher over-all efficiency.

The whole story of tomorrow's water softener today is told in brand new bulletin 606. Write for your copy today.

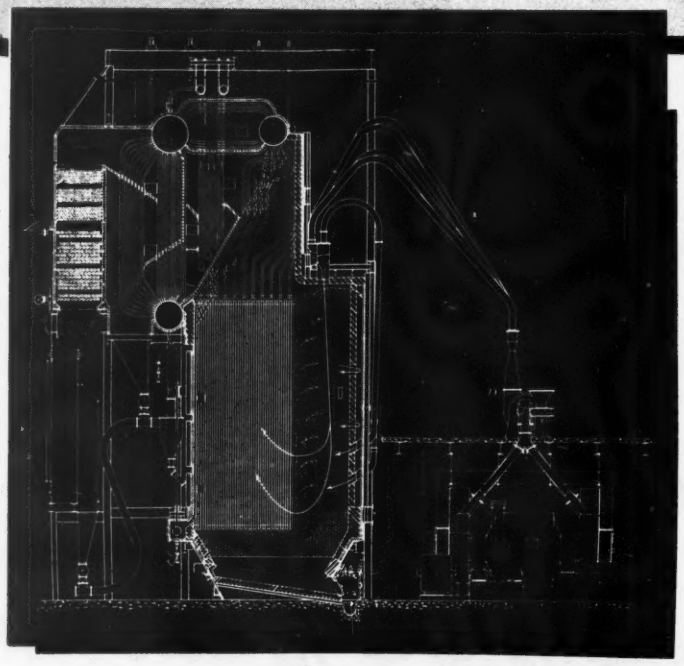
ELGIN *economical water conditioning*

The complete Elgin line—Boiler Water Treating and Purifying Systems • Feedwater Treatment • Deconcentrators • Heat Exchangers • Water Softeners • Filters and Purifiers • Iron Removal Equipment • Aerators • Water Treating Chemicals • Chemical Feeders • Scale and Corrosion Inhibitors • Sample Coolers • Water Testing Equipment • Zeolites

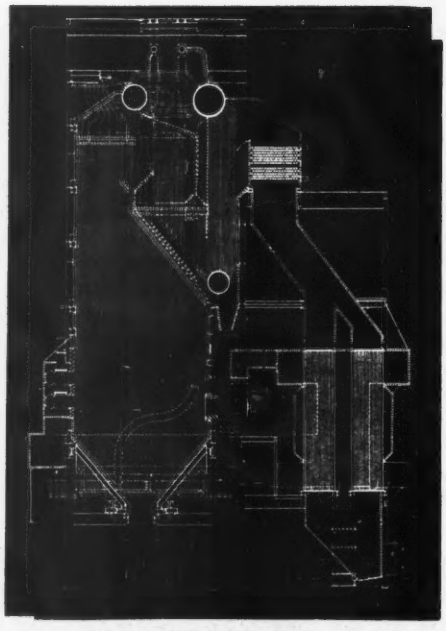
ELGIN SOFTENER CORPORATION, 136 NORTH GROVE AVENUE, ELGIN, ILLINOIS

STEAM GENERATORS

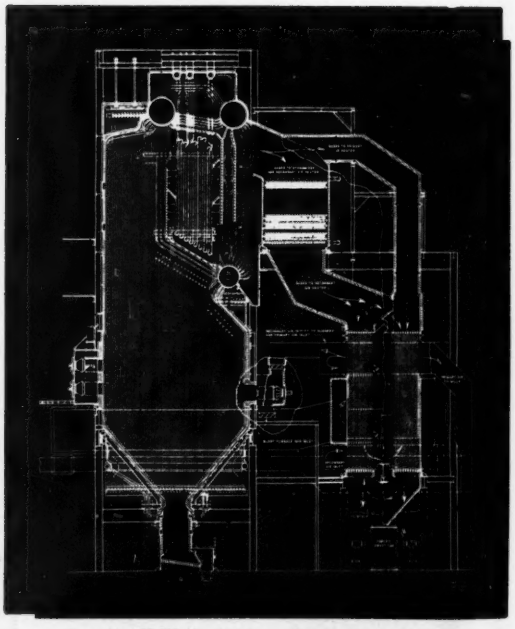
CAPACITIES



Capacity 165,375 lb. steam per hour, pressure 900 psi and final steam temperature 788 deg. F. Fuel: pulverized coal.



Capacity 385,000 lb. steam per hour, pressure 1050 psi and final steam temperature 900 deg. F. Fuel: pulverized coal and blast furnace gas.



Capacity 500,000 lb. steam per hour, pressure 1050 psi and final steam temperature 900 deg. F. Fuel: pulverized coal and blast furnace gas.

FW FOSTER

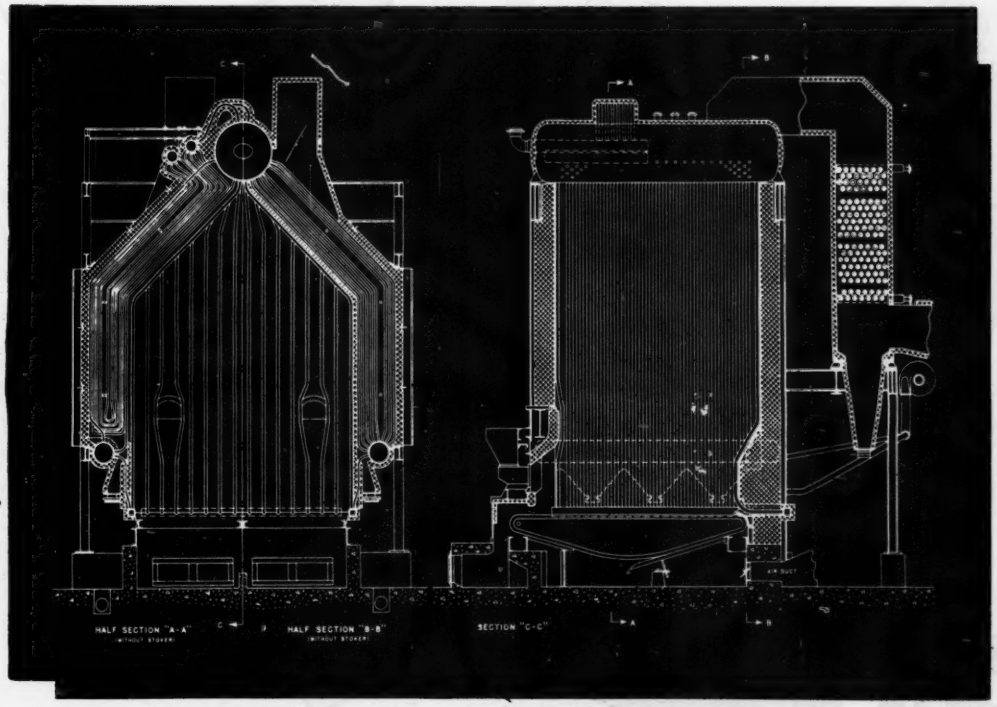
FOR RUSSIA . . .

66,000 TO 500,000 LB. STEAM PER HOUR

THE steam generators shown in the accompanying drawings represent 23 of the many boilers that Foster Wheeler has designed and built for Russia during the past two years.

Their capacities range from 66,000 to 500,000 lb. steam per hour, with pressures from 315 psi to 1050 psi and final steam temperatures from 707 deg. F. to 900 deg. F. To accommodate the variety of fuels available, these units are designed for stoker, pulverized coal and blast furnace gas firing.

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, N. Y.



Capacity 66,000 lb. steam per hour, pressure 315 psi and final steam temperature 707 deg. F. Fuel: coal on stokers or blast furnace gas.

WHEELER

TYCOL INDUSTRIAL

SCIENTIFICALLY ENGINEERED FOR

Summed up!

BE SURE TO MAIL THE COUPON FOR YOUR FREE COPY OF THIS INFORMATIVE LUBRICATION HANDBOOK

★ *How is the Carbon Residue of a lubricant determined?*

★ *What is the significance of a lubricant's Neutralization Number?*

★ *What means are employed to determine Flash Point?*

To get concise, understandable answers to these and other questions about lubricants, send for a free copy of the new edition of "Tide Water Lubricania". This 20-page illustrated booklet gives graphic explanations of the methods and equipment used to determine specific qualities of lubricants — Viscosity, Pour Point, Penetration and other important properties.

Even more helpful — the booklet explains briefly the significance of each property as it affects the performance of lubricants in specific services. Every user and buyer of lubricants will find this information particularly helpful as a guide to choosing the right type of lubricant for each requirement.

Since the terminology and test methods described are universally accepted, the information given in "Tide Water Lubricania" can be applied to all lubricants regardless of make. Thus the booklet makes a permanently useful addition to your lubricant specification files. Be sure to mail the coupon today for your free copy of this useful lubricant guide.

• • •

Tide Water lubrication experts are completely familiar with all phases of lubricant production and application. They know that the "Lubricania" tests are rigidly followed to build and maintain the high quality of Tycol Oils and Greases — quality lubricants scientifically engineered to meet every industrial use. Let a Tide Water engineer put that lubricant knowledge to work in your behalf. Write to your nearest Tide Water office for further information.

TIDE WATER ASSOCIATED OIL COMPANY

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL • Eastern Division: 17 Battery Place, New York 4, N. Y.

Principal Branch Offices: Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

DRUMS! DRUMS! DRUMS!

War needs make it extremely important that all empty drums be returned immediately

LUBRICANTS
EVERY INDUSTRIAL USE

PE

TIDE WATER ASSOCIATED OIL COMPANY
17 Battery Place, New York 4, N. Y.

Please send me a free copy of the latest edition of your illustrated booklet "Tide Water Lubricania."

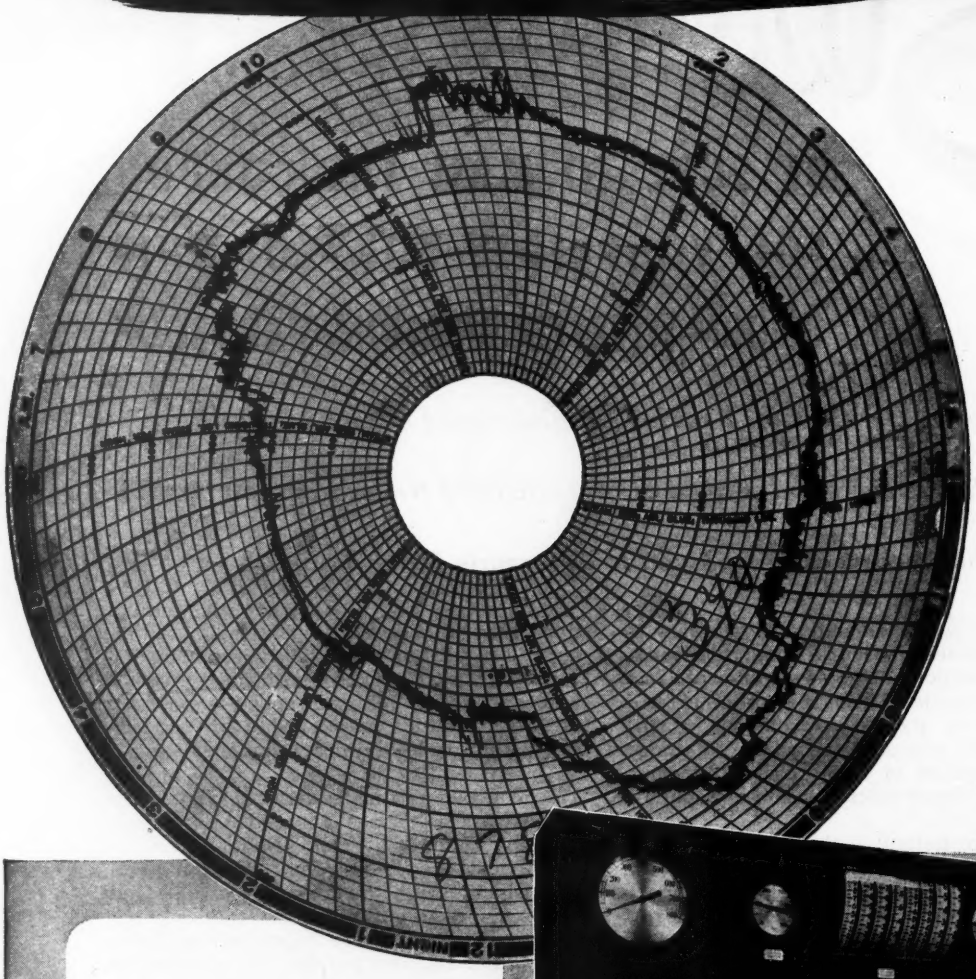
Name_____

Company_____

Address_____

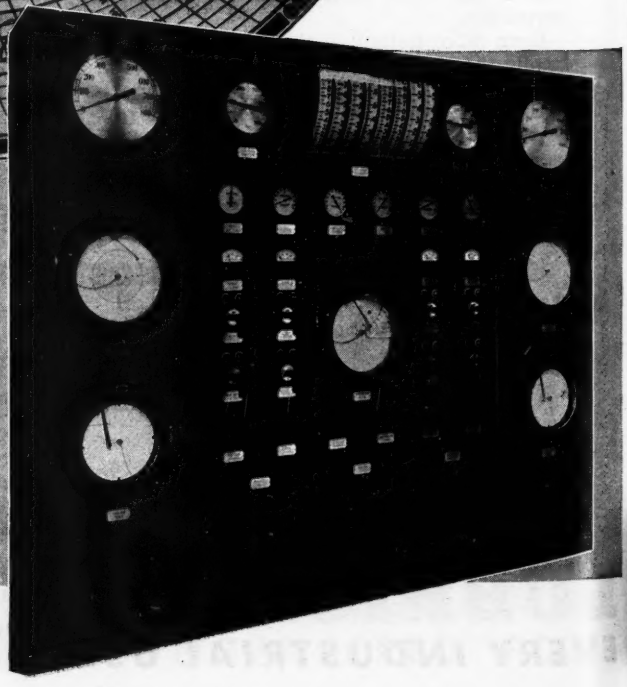
City_____ State_____

FOR THE UTMOST IN



Steam and air flow chart taken from a Hagan controlled boiler. Note the close control of air in relation to steam flow.

A mechanical brain that thinks for your operating staff and makes all changes quickly and automatically. Hagan Control responds to the slightest fluctuation of steam, gets maximum efficiency from your boilers.



COMBUSTION CONTROL

...Look to Hagan!

HAVE you ever wished for combustion control so finely engineered and so dependable that it would operate at maximum efficiency with little or no attention?

Have you ever wanted a system so simple, sturdy and fool-proof that it gives you accurate, dependable performance, year in and year out, with a minimum of maintenance?

Would you like the assurance that you would be getting the utmost benefit from every pound of fuel?

Then you can safely look to Hagan. For that is the kind of control service it is giving to its thousands of users. You can read the story on their control charts.

Hagan Automatic Combustion Control was the first efficient system for its purpose ever built. The Hagan record has been one of continuous pioneering of major improvements ever since. This unbroken leadership has but one explanation: the employment of the right control principles by engineers with the greatest wealth of combustion experience.

For complete facts in support of these statements just write or call us.

HAGAN CONTROL ASSURES:

MAXIMUM QUANTITY of steam from any given plant, by introducing fuel and air in correct proportion.

MAXIMUM UTILIZATION value and uniform steam pressure.

MAXIMUM OUTPUT from boilers of different capacities.

MAXIMUM PROTECTION of auxiliary equipment, fans, stokers, etc., by maintenance of uniform operating conditions.

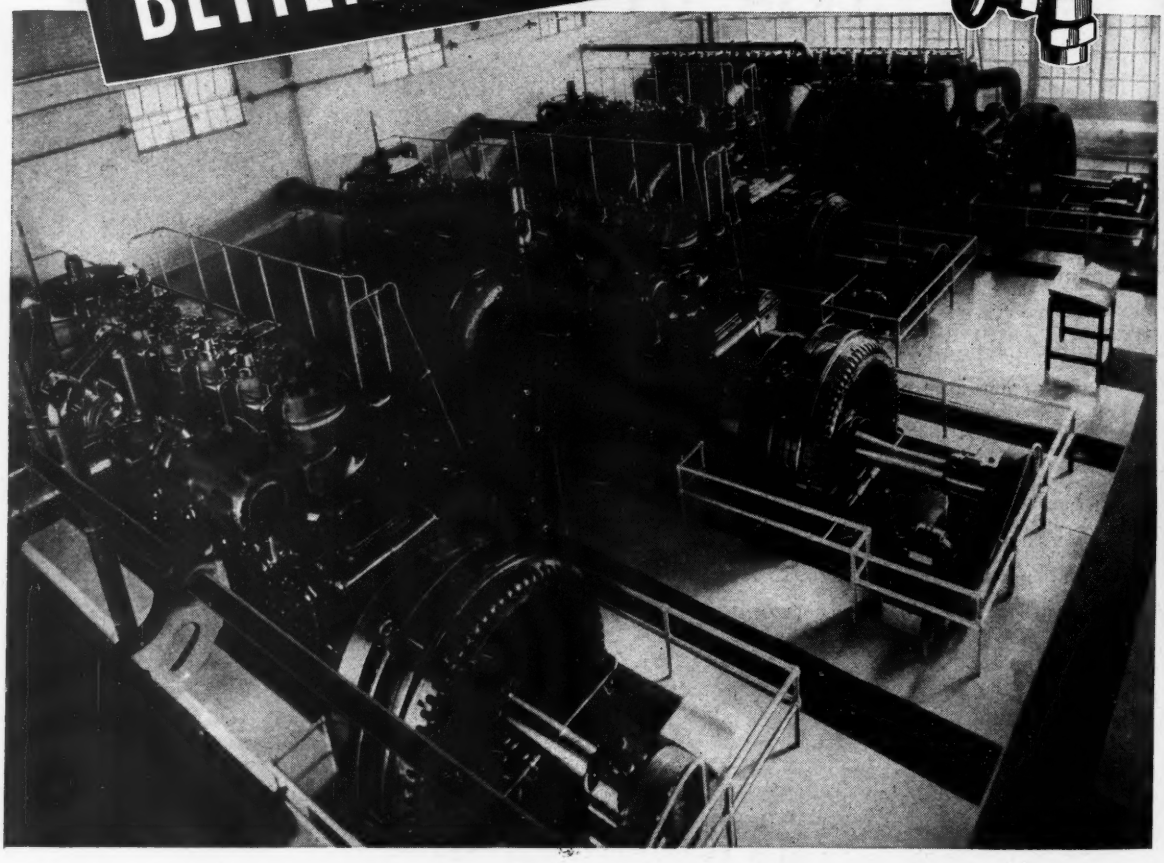
HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

BETTER LUBRICATION *means* BETTER MAINTENANCE



IF you are experiencing difficult maintenance, better check lubrication. It may be inadequate with resultant excessive wear.

Sinclair offers better lubrication for better maintenance of DIESEL equipment. Sinclair RUBILENE and GASCON OILS have high oiliness and non-oxidizing, non-sludging qualities. They reduce ring and liner wear... prevent scoring and ring-sticking.

• • •

(Write for "The Service Factor"—published periodically and devoted to the solution of lubricating problems.)

SINCLAIR INDUSTRIAL OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

Pin Up Tomorrow's KVA

Your plant power circuits, as well as your machines, deserve modern "production-line" planning

Electric power supply is your plant's most critical "materials handling" problem. If your power distribution is of the prewar variety, it may be an inflexible handicap to full-scale reconversion planning. Substation location will be restricted to vaults, or locations distant from the loads. Even if the circuits can handle the loads, switchgear of inadequate interrupting capacity will be a threat to continuous production and a danger to plant personnel.

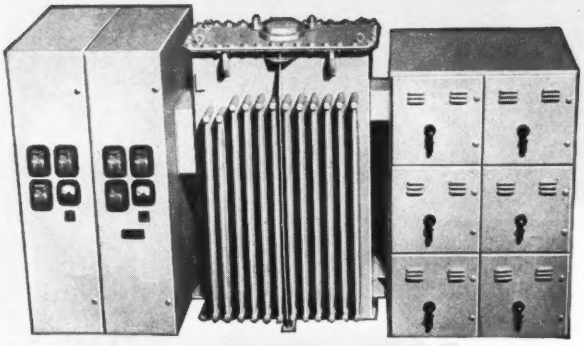
Whatever your other reconversion plans, consider this: Cost figures now generally favor the new kind of power distribution system that puts *unit substations close to the load centers*. It's the system that gives you the greatest flexibility to meet change or growth, with full voltage at every machine. Continuity of service will be more completely assured. Yet your planning and installation jobs are greatly simplified.

GENERAL ELECTRIC

Here's *how* G.E. can help you

Our wartime experience in planning power distribution systems around G-E load-center unit substations mean better layouts more quickly arrived at, for old plants or new.

LOAD-CENTER *Unit Substations*



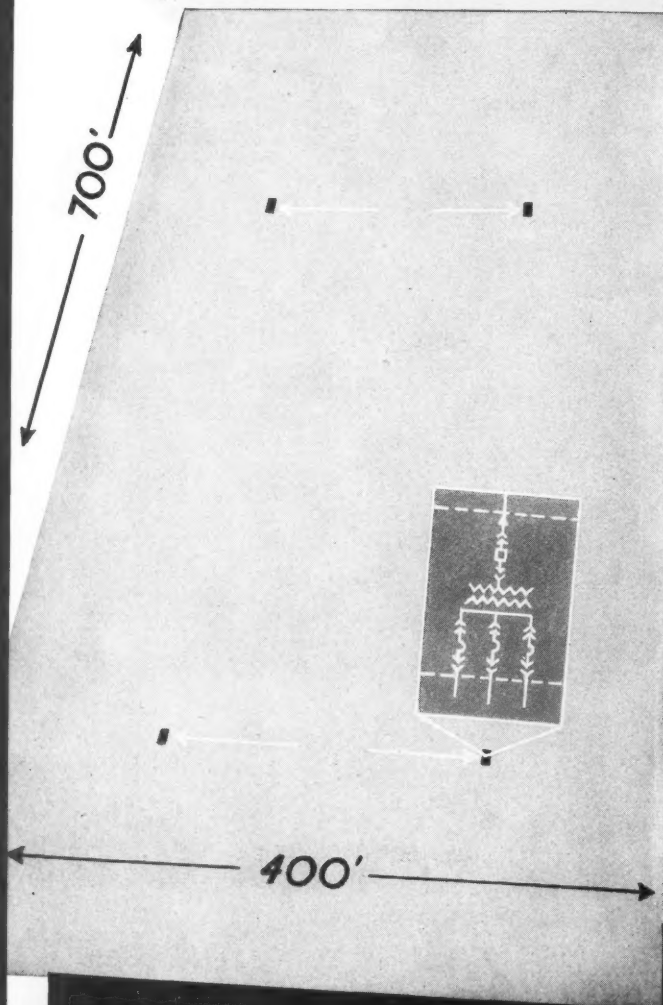
Are you losing out on the power savings and short-circuit security of load-center power distribution because of a seeming lack of space for unit substations?

Hundreds of installations of unit substations have been made in crowded quarters, with the help of G-E engineers. They show that these substations can almost always go in close to the load centers in available space that's unusable for production.

In load-center power distribution, you have a way to get good value from this otherwise useless space. For every unit substation pays its rent—and then some—in terms of fewer power interruptions, lower losses, greater short-circuit protection, better voltage conditions, reduced hazard to personnel!

G-E unit substations are complete, compact, "go-anywhere" units. The transformer is efficiently cooled with (non-burning) Pyranol. The switchgear is completely metal enclosed. Easy to install, even in out-of-the-way locations, these substations are self-protected from dampness and dirt. They can adjoin aisles or locker rooms without creating a hazard.

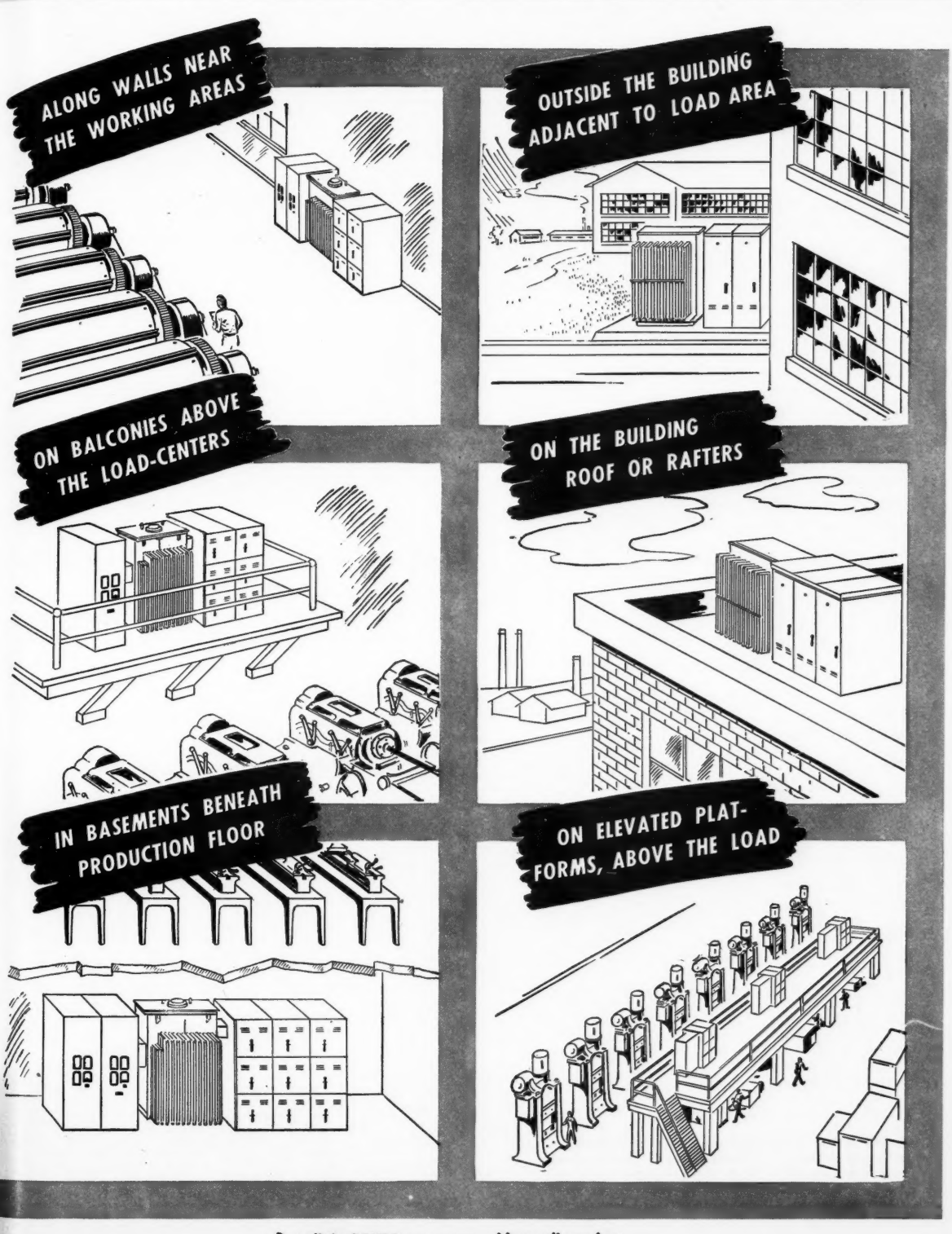
Before you plan a new plant, or start extending or modernizing an old one, ask G.E. for the complete story. The chances are we've already helped meet power problems or space probems comparable with your own, and can cite performance figures to prove the benefits. *General Electric Company, Schenectady 5, New York.*



In this modern system, power is distributed from metal-clad switchgear or master unit substation at relatively high voltage (2.4 to 13.3 kv) to load-center unit substations located near the centers of electrical load areas. There it is stepped down to utilization voltage (below 600 volts) by the compact Pyranol transformer section and distributed to the load through drawout air circuit breakers and short secondary feeders.

Even when mounted right on the factory floor, unit substations seldom occupy more than 1/500 of the load area they serve. (Diagram shows typical floor plan to scale for average load conditions. Yet each small rectangle includes the step-down transformer and switchgear shown in the inset view.)

PAY RENT FOR "Unusable" SPACE


ALONG WALLS NEAR THE WORKING AREAS
OUTSIDE THE BUILDING ADJACENT TO LOAD AREA
ON BALCONIES ABOVE THE LOAD-CENTERS
ON THE BUILDING ROOF OR RAFTERS
IN BASEMENTS BENEATH PRODUCTION FLOOR
ON ELEVATED PLATFORMS, ABOVE THE LOAD

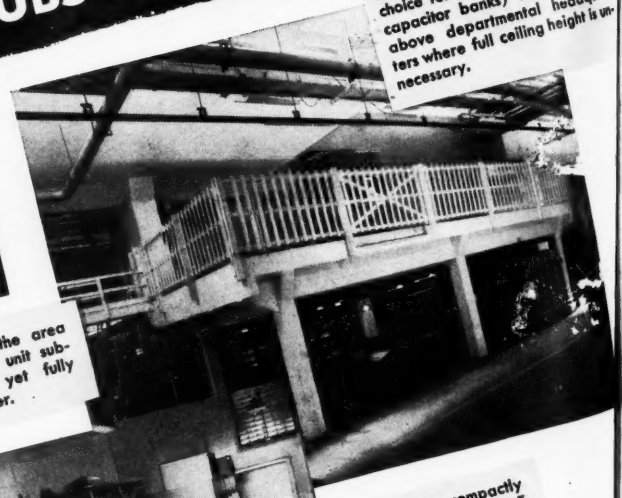
Buy all the BONDS you can — *and keep all you buy*

GENERAL ELECTRIC

Here's the Answer

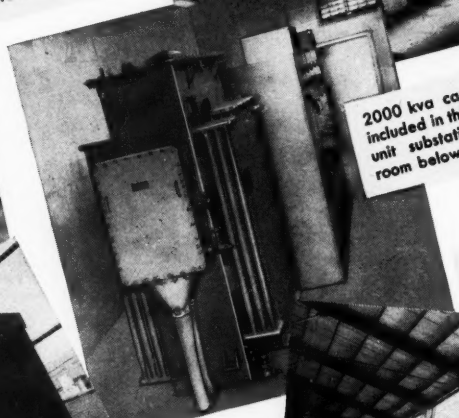
THAT THESE PLANTS FOUND FOR SPACE-SAVING SUBSTATION LOCATION

On this balcony, two G-E unit substations (300 kva in foreground, 100 kva in rear) are accessibly located near the load centers they serve.



Elevated platforms were the choice for eight substations (plus capacitor banks) here. They go above departmental headquarters where full ceiling height is unnecessary.

Outdoors, adjacent to the area served, this 1500 kva unit substation is accessible, yet fully protected from weather.



2000 kva capacity is compactly included in this double-ended G-E unit substation in a basement room below the working area.

This corner location on the working floor gives high accessibility to switchgear. In new plant layouts, it's a favored choice.

On a building roof, this 500 kva substation occupies otherwise unusable space at a point where secondary feeders can be short and direct.

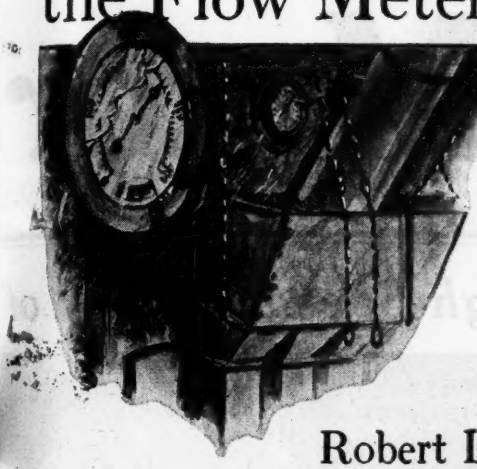
A NEW, COMPLETE FACT-BOOK on G-E load-center distribution systems, giving the full story of their successful use, is being prepared. Ask your G-E representative to send you a copy as soon as it is printed. Ask for the new edition of GEA-3592. *General Electric Co., Schenectady 5, New York.*

LOAD-CENTER
Power Distribution Systems

GENERAL ELECTRIC

3012-34-6900

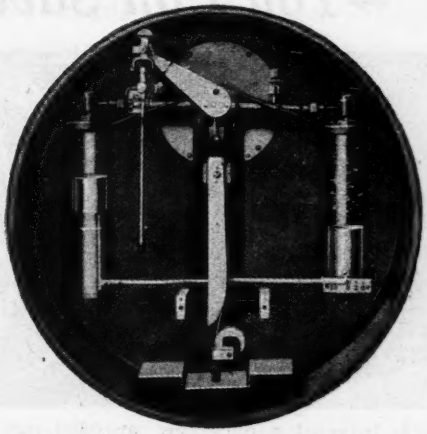
The Story of the Dirty Boiler Room and the Flow Meter with the Cracked Glass



This one belongs in the famous "Believe It or Not" series of Robert L. Ripley:

A Cochrane Flow Meter, of the tilting U-tube type, was installed in a boiler room, which, far from being the bright, clean, "eat-off-the-floor" variety the readers of this magazine are familiar with, was very dirty indeed. The operators, again unlike our readers, were probably rather careless, for the glass on the meter door was cracked and no one bothered to replace it. The meter, being of the indicating type, required no change of chart, or other excuse for opening the door, but continued to function properly for two years. Then there was an inspection, and it was found that the meter case was half-filled with coal dust...and that the tilting manometer had kept ploughing a clear path for its operation. Its accurate performance had not been affected. That's POWER!

What is the secret of this power inherent in every Cochrane Tilting U-tube type of Flow Meter?

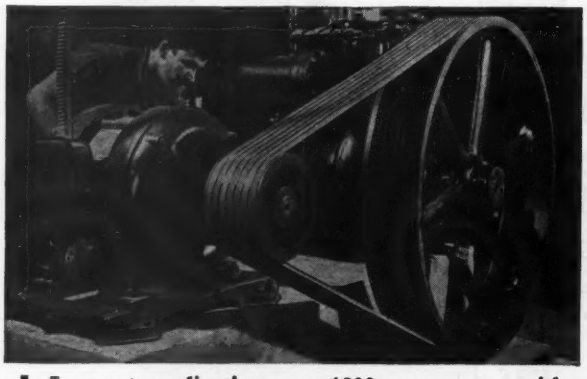


Simply this: the difference in rate of flow in the pipe line changes the level of the mercury in a sealed U-tube which is balanced on a knife-edge bearing. As the mercury shifts from one side to the other of the U-tube, the balance swings, moving indicator, pen arm and integrator to record the change in flow.

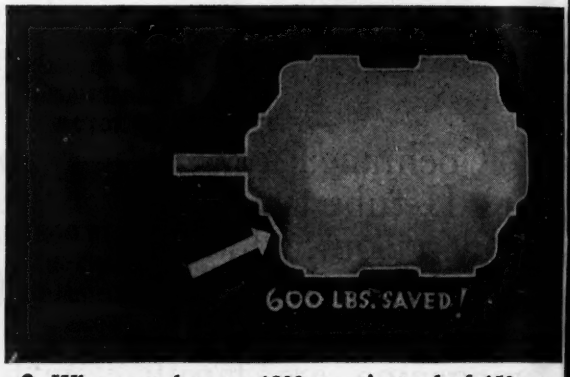
Simple . . . powerful . . . never-failing. If you have a tough metering job, if your operators are unskilled in instrument care and maintenance, if you want the simplest and most powerful flow meter made, this Cochrane Tilting U-tube Meter was made for you. Write today to Cochrane Corporation, Flow Meter Division, 3123 N. 17 St., Philadelphia 32, Pa.

It's Time to Look at Motor

➡*You Can Save with High-Speed Instead of*

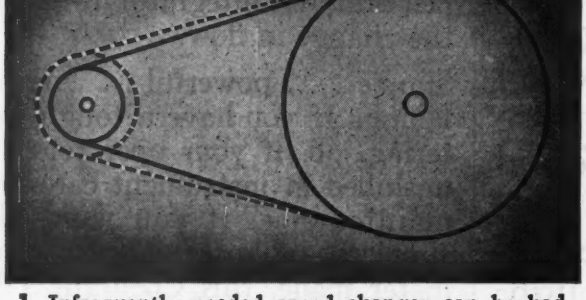


1. In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor . . . *and* give you *exactly* the speed you want — *at lower cost!*



2. When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb of critical materials are saved. And *you* save well over $200—with the drive figured in! This saving is typical.

➡*You Can Save with Single-Speed Instead of*



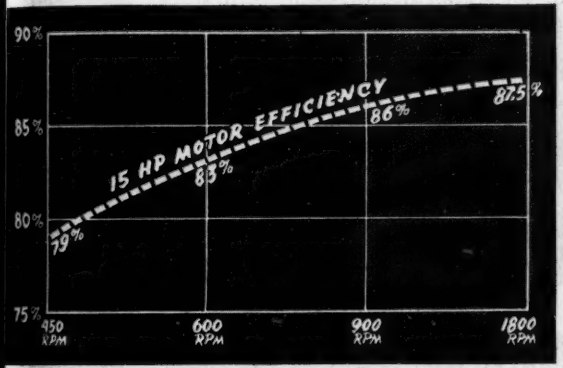
1. Infrequently needed speed changes can be had by changing from one size motor sheave to another. By juggling *complete* drives, speeds can be changed over the full range — from 1:1 to 7:1.

2. With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter, as above. Within limits, an unbroken series of speeds can be obtained.

Take a Fresh Buying!

WAR FORCES HIGHER EFFICIENCIES...

Low-Speed Motors...



3. Note that efficiency rises from 79% for a 450 rpm motor to 87.5% for an 1800 rpm motor. Comparing power consumption, the 1800 rpm motor saves you over 30 kwh/24 hr. day.

Multi-Speed Motors...

3. Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's the most compact, flexible variable-speed transmission available.

It was good business in peacetime to use — as widely as possible — high-speed motors with Allis-Chalmers Texrope Drives...and single-speed motors with Allis-Chalmers Vari-Pitch Sheaves and Speed-Changers. And it's clearer every day that those material and money-saving practices are *vital* practices in time of war!

TODAY the whole picture of buying and applying motors has changed. Note at the left how much you can save for your country *and yourself* with high and single-speed motors made flexible by Texrope Drives.

As America's only builder of both electric motors and V-belt drives, Allis-Chalmers has long advocated the proper combining of motor and V-belt drive.

And today you benefit from Allis-Chalmers' vast, pioneering experience in this field when you ask for and get the *right* combination of Lo-Maintenance Motor and Texrope Drive! Call your nearby district office. Or write ALLIS-CHALMERS MFG. CO. MILWAUKEE, WISCONSIN.

A 1560

♪ Tune in the Boston Symphony, Blue Network, Saturday at 8:30 pm, EWT.

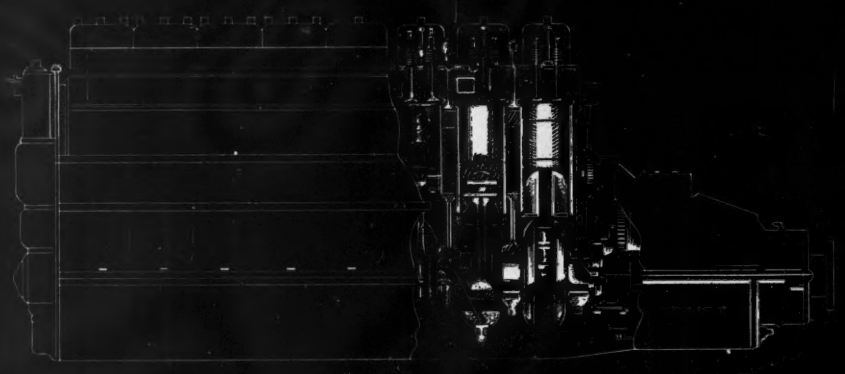
ALLIS-CHALMERS AC MILWAUKEE

WE WORK FOR VICTORY

WE PLAN FOR PEACE

EXAMPLE OF *Service*:

One of our Cities Service Engineers writes: "We've been lubricating the Diesel engines owned by the Consumers Steel and Supply Company, at Racine, Wisc., for four years (about 43,200 engine hours) and at no time has there been trouble traceable to lubrication. Engines are always free of carbon and never show ring-sticking . . . even though the Diesels carried full to over-loads 60% of the operating hours."



More and more, it's service that counts . . .

and *Cities Service* means good service!

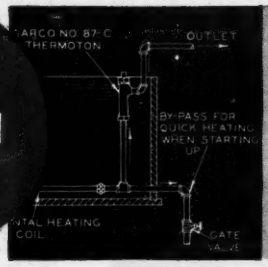
CITIES SERVICE OILS — ONCE-ALWAYS

CITIES SERVICE OIL COMPANY

ARKANSAS FUEL OIL COMPANY

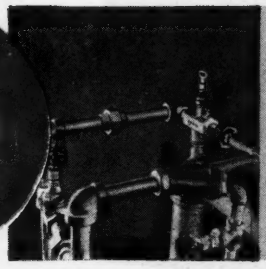
STEAMATHEMATICS

(A NEW DEFINITION OF SARCO SERVICE)



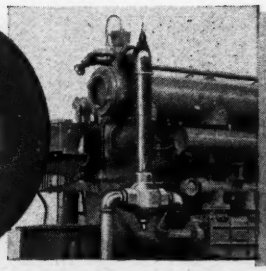
SARCO No. 87 ADDS

The Sarco No. 87 steam trap adds steam in plating tanks, and outdoor tank coils as needed and maintains a constant temperature.



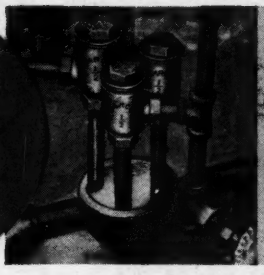
SARCO TR-40 SUBTRACTS

The Sarco TR-40 cooling control reduces temperatures in condensers and engine and compressor jackets by controlled circulation.



SARCO MB BLENDER DIVIDES

The Sarco water blender, a three-way mixing valve, proportions the amount of hot or cold water entering the line for showers, process operations and engine jacket cooling.



SARCO No. 9 MULTIPLIES

Because a trap pushes out the air so steam can follow and because it removes condensate as fast as it forms—it multiplies the effective output—especially when a separate trap is used on each coil.

The Sarco Hook-Up book—hints and kinks from a quarter of a century's experience with calculation data, recommendations and hook-ups for every industry. Free for the asking.

42 42

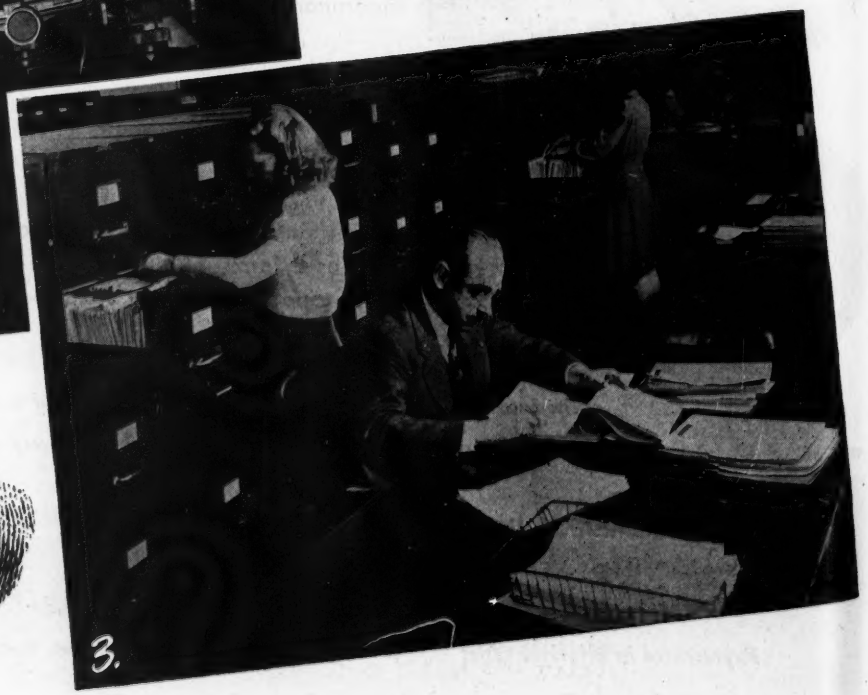
SARCO COMPANY, INC.
475 FIFTH AVENUE
NEW YORK 17, N. Y.

Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO

Why Hall System is as



distinctive as finger prints

We have made no mystery of Hall service. The developments of our research have always been published. Much of what we have learned is now common knowledge. Why, then, do we say that the Hall System is as distinctive as one's finger prints? It is really quite simple. Hall System of Boiler Water Conditioning stands on 3 legs like a tripod. Each leg is of equal importance. Each is a peculiarly Hall creation.

1. Preventive Care. **This is based on the sound theory that if you know how to read the signs right, if you do the right things at the right time, you will seldom experience an unscheduled boiler outage. This is a strictly cooperative program. You and a Hall expert work together.**

2. Laboratory Research. **Heart and base of Hall theory is the conviction that scientific diagnosis is the one safe approach to a cure for boiler water evils. We have no faith in cure-alls or packaged remedies. That is why Hall field men are trained specialists not salesmen.**

3. Continuity. **One cannot keep a boiler operating at top efficiency by hit or miss observation. That is why we start a case history on each plant serviced. Constant, intelligent supervision is the only real protection.**

But the real way to appreciate the distinction between Hall service and any other is to watch it at work—*in your own plant*. To help you make that important decision let us look your situation over and tell you how we could do for you what we are doing for so many others.

HALL LABORATORIES · HAGAN BUILDING · PITTSBURGH 30, PA.

HAGAN
HALL
BUROMIN
CALGON

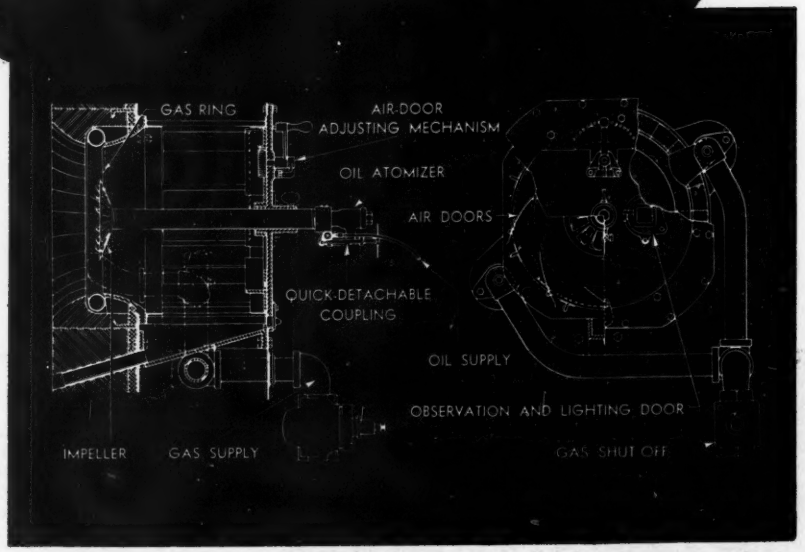
HALL SYSTEM
of Boiler Water Conditioning

Hall Service in a Nutshell

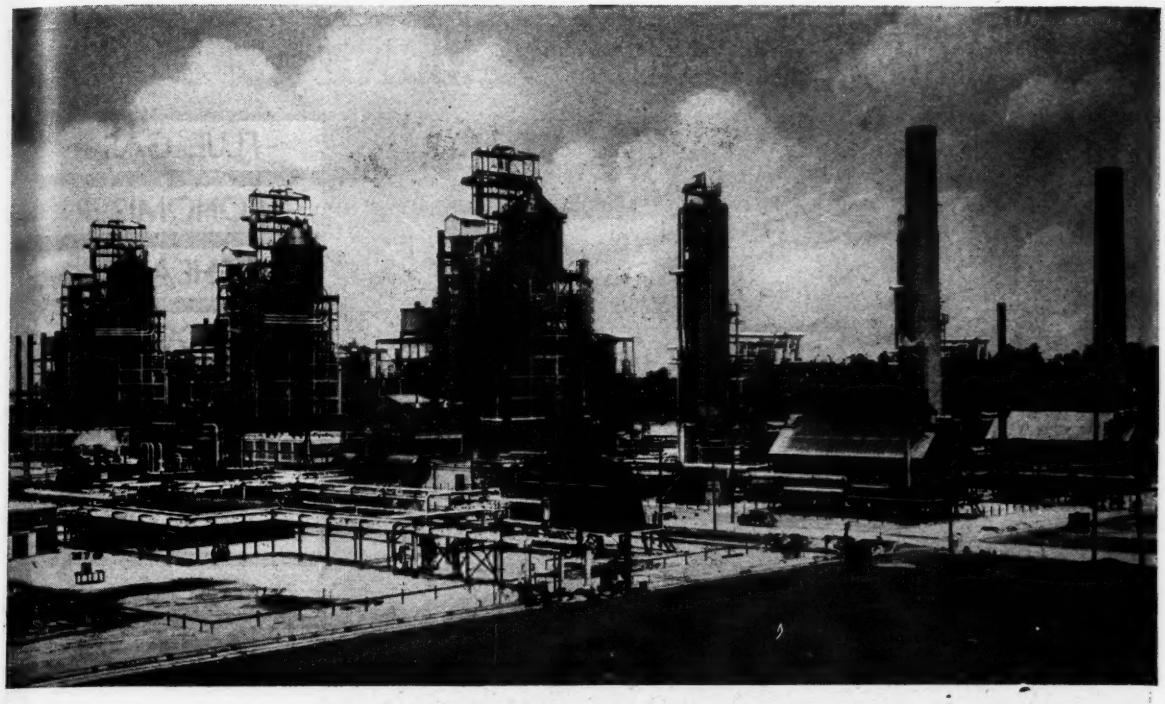
At your immediate disposal are placed the technical knowledge and facilities of the pioneering leaders in scientific boiler water conditioning. In addition, with your full cooperation, Hall Service:

1. **Minimizes boiler outages caused by water.**
2. **Helps maintain highest efficiency.**
3. **Establishes non-embrittling water.**
4. **Minimizes carryover.**
5. **Prevents corrosion in boilers and associated equipment.**
6. **Prevents deposition in water lines and cooling systems.**

THIS TEAM



Combination fuel gas and oil burners of this type are installed on boilers at Lake Charles.



Lake Charles

Six Babcock & Wilcox boilers help to provide power and process steam for the new giant Cities Service refinery at Lake Charles, Louisiana. Two are the B&W Integral-Furnace type, and teamed with them are 23 B&W burners on these and other boilers in the plant.

Providing tankfuls for task fliers calls for uninterrupted production . . . makes "steam up" as important as "on stream" . . . demands a high standard of efficient performance from generating equipment. B&W Integral-Furnace Boilers are a "known quantity", proved dependable in war industries as in pre-war services . . . now serving steel mills as well as refineries; arsenals and aircraft factories as well as butadiene plants.

Experience gained in unprecedented war-time assignments added to years of steam progress, will be reflected in the service of B&W Integral-Furnace Boilers to post-war industry.

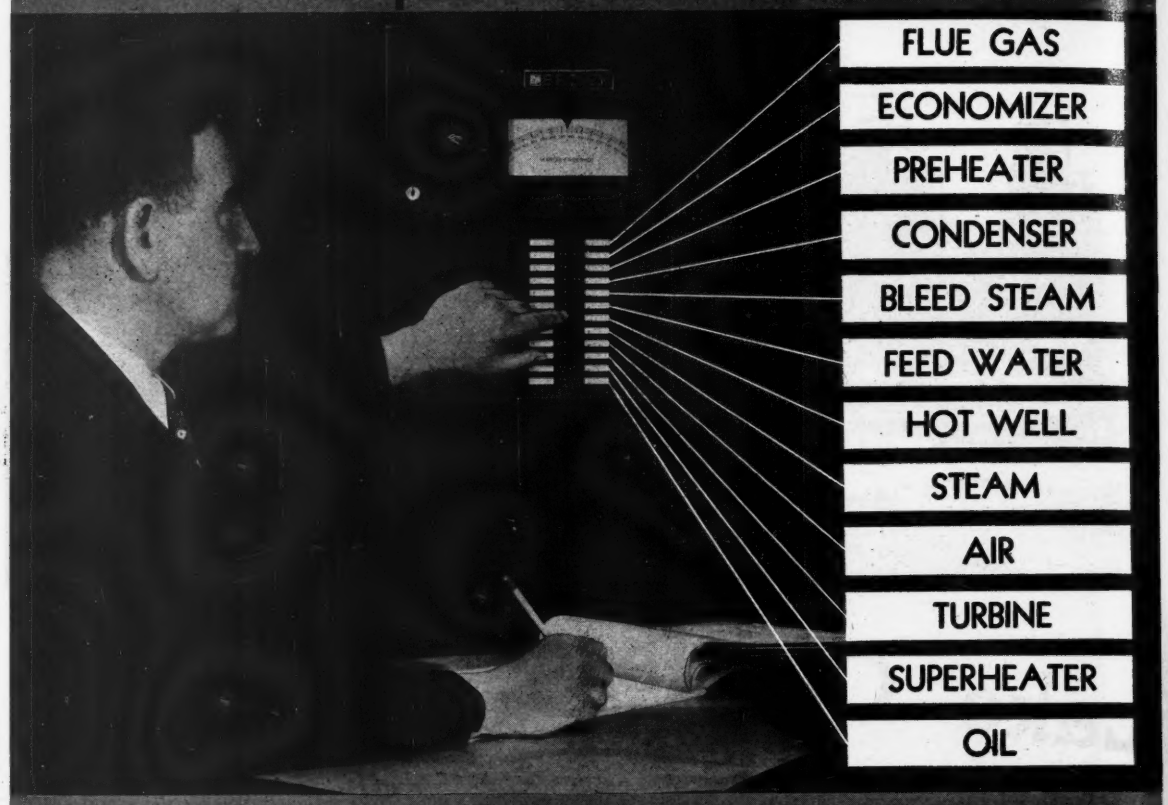
BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 Liberty St., New York 6, N. Y.

BUY MORE WAR BONDS

G-2767

Check these Temperatures within a Few Seconds



ELIMINATES MANUAL BALANCING

The self-balancing Centralized Reading Indicator pictured above is as modern as jet propulsion.

The operator merely touches the desired switch. The instrument does the rest, leaving his hands free to log readings.

Time required between readings is limited *ONLY* by human ability to pick off a reading. Compare this time to that required to read an outmoded *manual* balance indicator, designed when shaving mugs were on every barber shop shelf.

The Brown Centralized Reading Indicator is unique for other reasons too.

The electronic "Continuous Balance" principle delivers sensitivity previously unheard of. Fancy being able to read one part in twenty-four hundred!

The ElectroniK is totally unaffected by vibration—mount it on a pulverizer frame if it suits your purpose.

The ElectroniK utilizes circular instead of reciprocating motion. Components move only when the scale is changing position.

Specify the Brown Precision Indicator for that post-war boiler.

Specify it, too, for your present station. Utilizing the same wiring and thermocouples, it readily replaces old-fashioned instrumentation.

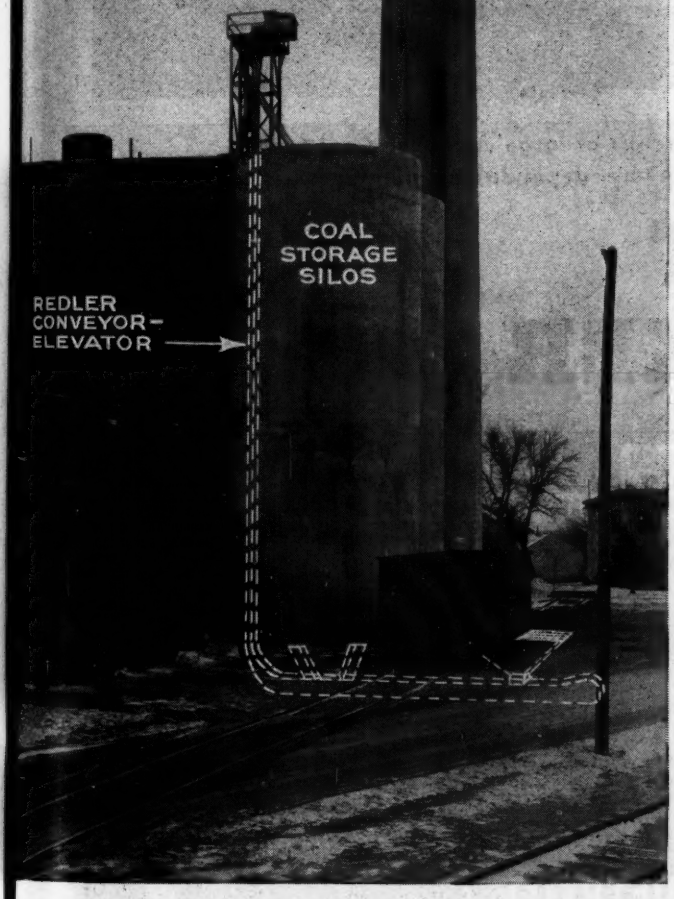
Write for Bulletin 15-4, The Brown Instrument Company, *a division of Minneapolis-Honeywell Regulator Company*, 4491 Wayne Avenue, Philadelphia 44, Pa. Branches in all principal cities. Canadian factory: 119 Peter Street, Toronto, Canada; Wadsworth Road, Perivale, Middlesex, England; Nybrokajen 7, Stockholm, Sweden.

BROWN *Electronik*

POTENTIOMETERS

The Problem—

To move coal from cars to storage and reclaim for boiler room use.



HOW S-A ENGINEERS *Solved the Problem*

Here's a typical example of how coal handling at power plants can be greatly simplified — and at the same time made more efficient.

A coal handling system consisting of three REDLERS accomplished the entire job, from track hopper to boiler stoker.

The L-shaped REDLER Conveyor—Elevator (shown dotted in the photo) is the key factor to efficient, low-cost handling in this plant.

The need for a separate feeder under the track hopper was entirely eliminated and not only does the REDLER convey and elevate incoming coal from railroad cars to twin storage silos, but the *same unit* also reclaims coal from either or both silos for delivery to the boiler room via two horizontal REDLER conveyors located on the roof.

Simplicity of arrangement, coupled with compactness and dust-tight handling show what can be done when the *right equipment* and the *right method* are brought to bear on a specific problem. For further information on coal handling equipment, write us today.

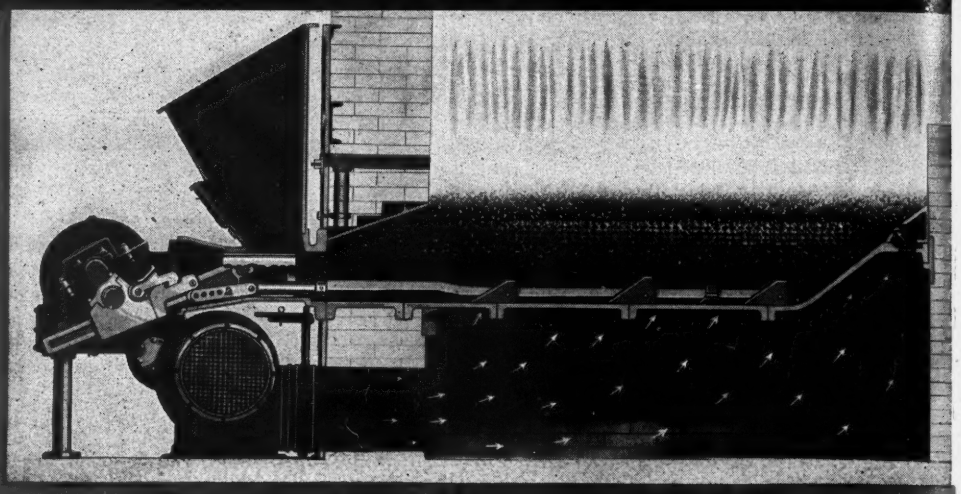
STEPHEN S-A ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT

IT'S THE DESIGN



Deep sectional furnace of large capacity. Coal feed and distribution by dependable plunger feed.

DETROIT UNISTOKER

Provides flexibility to handle fluctuating loads.

HEAVY MECHANICAL DRIVE REQUIRES LITTLE POWER
SAFETY SHEARING PIN
HAND COAL ADJUSTMENT
AUTOMATIC ADJUSTMENTS OF COAL AND AIR SUPPLY
DETROIT ADJUSTABLE FEED
(COAL FEED CONTROL)

DETROIT STOKER COMPANY

and APPLICATION

DETROIT UNISTOKER

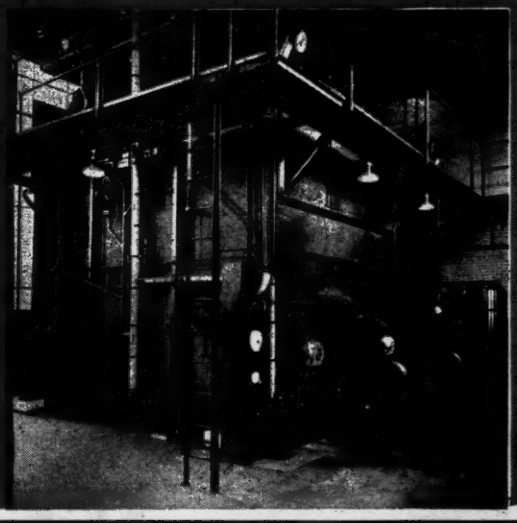
Saves Fuel and Labor

AUTOMATICALLY CONTROLLED

Feeds coal only when needed. None is wasted. Grate area is large. All of the fuel bed is active. Burning rate per square foot of grate is low. Side Cleaning—ashes are discharged to ash pits at each side of furnace. Design is simple and compact. A proven success. Readily applied to all boiler types. Thousands in Daily Operation.

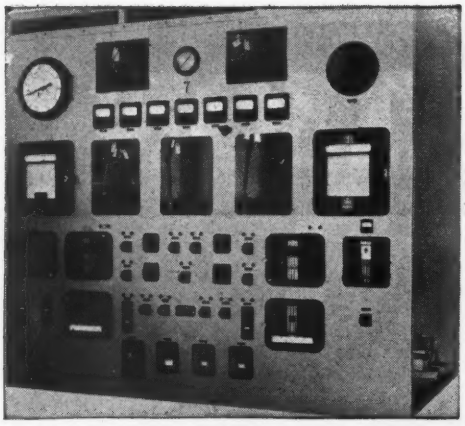
In Pennsylvania—with Steam Generators.

In Virginia—with Low Head Bent Tube Boilers



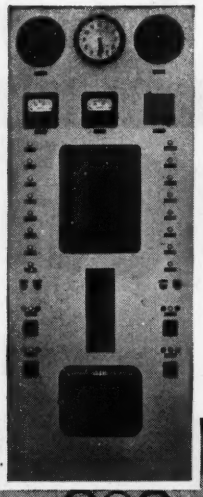
GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

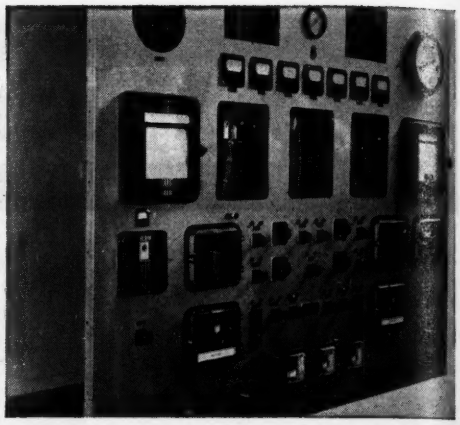
Works at Monroe, Michigan • District Offices in Principal Cities • Built in Canada at London, Ontario



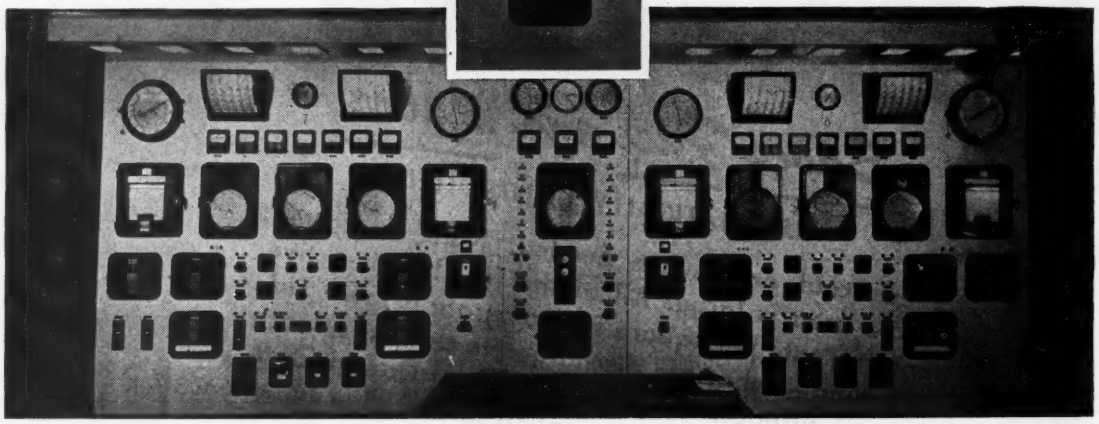
Ready for shipment—left section of panel shown below.

Center section, showing signals and accessories.





Right section, before delivery. Note wired cutouts.



Complete 3-section panel—with illuminating hood attached, wired and labelled cutouts (shown above) mounted with desired instruments.

Designed and supplied by L&N for Pennsylvania Electric Company's Front St. Station, Erie, Pa.

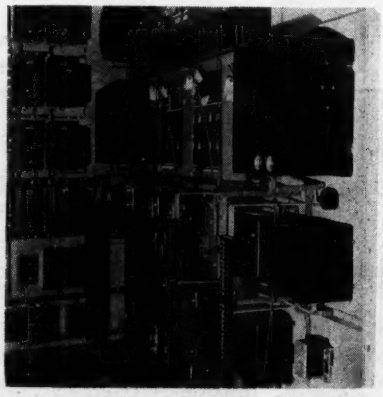
PANELS—COMPLETE AND READY TO INSTALL

This boiler-control panel for "Penelec" in Erie, Pa., demonstrates two of the features we put into every one of the many panels we build:

1. Its instruments and controllers, switches, signals and all accessories are grouped for the greatest convenience of the boiler operator. As makers of Metermax Combustion Controllers, Micromax Superheat Controllers, Micromax Recorders for CO_2, temperature, smoke, conductivity, pH, frequency, etc., we are well equipped to design the most efficient and practical panel for your plant's particular problem.

2. Panels reach you ready to install. Most instruments and controllers are in place; wiring is entirely completed and factory-tested. Instruments which we do not make can be supplied on request, or cutouts, wired and labelled, can be left for them, as was done on the panels shown above.

When you buy new instruments, consult an L&N engineer about another important L&N service—the supplying of control panels.



Rear view of L&N built panel—every wire neatly run and every connection checked.

depends on me!
A Slogan For Every American

Jrl. Ad NU-52(1)

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

4976

Smooth Running of DE LAVAL EXHAUSTERS pleases plant operators

THE three De Laval turbine driven exhausters here shown are highly praised by the personnel responsible for their operation and maintenance.

They draw gas from holders in which it is received from water gas generators and force the gas through condensers, scrubbers and purifiers, light oil scrubbers and meters to storage holders, where it is mixed with natural gas from pipe lines.

The units are rated to deliver 2280 to 5700 cu. ft. per min. each, with a maximum pressure differential of 60 ins. water column. In order to provide the wide variation in capacities and pressures, the operator can at any time, by the simple adjustment of a needle valve, set the variable speed hydraulic governors on the turbines for the speed desired.

The rugged cast iron construction of the blower casing insures good alignment and quiet operation in spite of sudden changes in delivery. Both the turbine casing and blower casing are split horizontally, providing complete accessibility.

The turbine and the blower each has its separate shaft and bearings, the two shafts being connected by a lubricated, all-metal, flexible coupling. This four bearing construction is more rugged and smoother running than is the overhung type of turbine blower unit with only one shaft and two bearings for the two members, as it is less likely to be unstable and to whip when slight unbalancing or wear occurs.

If you use blowers or compressors you will be interested in the wealth of data contained in our new Compressor Catalog F-3819.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

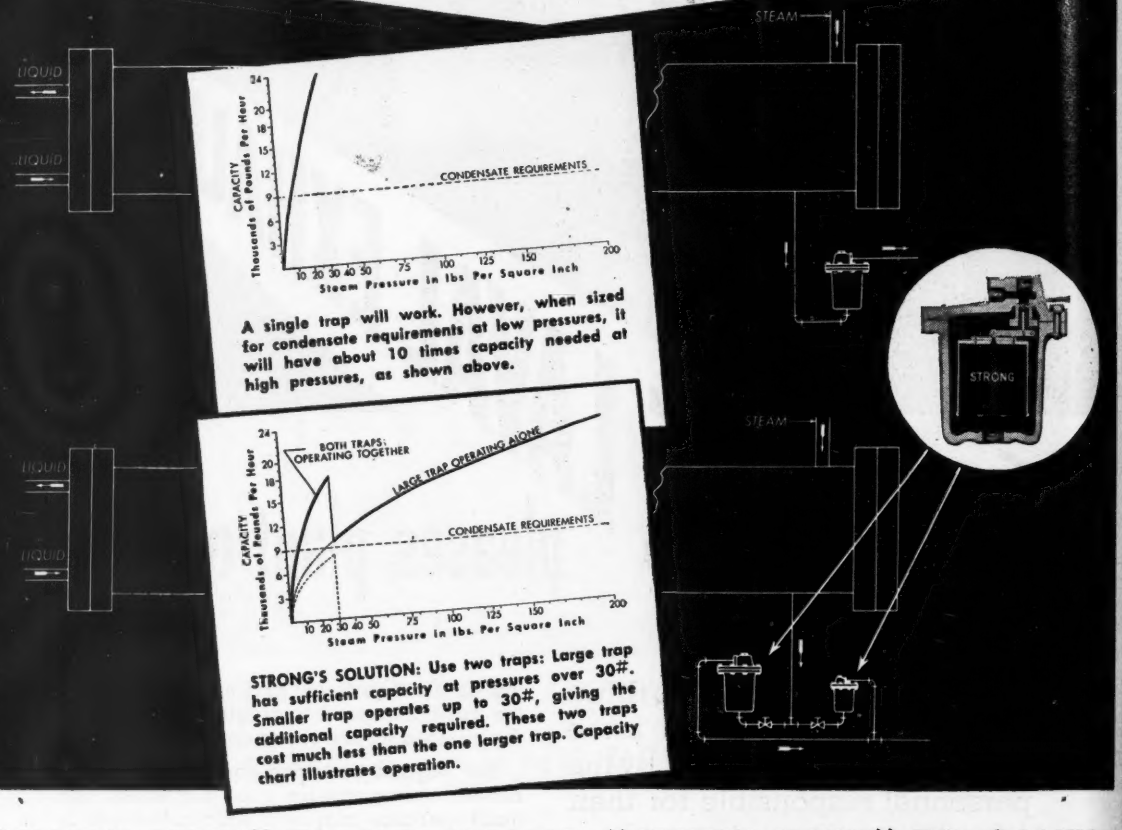
SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

WHERE 2 TRAPS COST LESS THAN 1

PROBLEM: Extreme pressure variation.
EXAMPLE: Heat exchanger with pressures, from 10# to 200#; condensate 9,000# per hour.

A single trap will work. However, when sized for condensate requirements at low pressures, it will have about 10 times capacity needed at high pressures, as shown above.

STRONG'S SOLUTION: Use two traps: Large trap has sufficient capacity at pressures over 30#. Smaller trap operates up to 30#, giving the additional capacity required. These two traps cost much less than the one larger trap. Capacity chart illustrates operation.



"KNOW-HOW" TO DO MEANS "KNOW-HOW" TO SAVE!

There are always different ways to apply steam traps to a given problem.

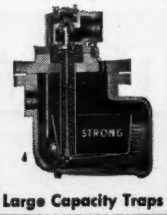
Some are better than others, and reduce steam costs or increase production or insure product quality. Here efficiency means economy.

Occasionally, less expensive hookups can give the same results as costly equipment. Here ingenuity, thorough knowledge and a complete line of steam specialties give a practical answer at desirable savings.

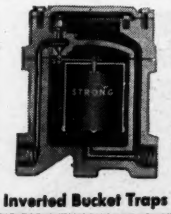
In either case, the "know-how" of Strong engineers is at your service. Their recommendations are backed both by long experience and the complete Strong line, including open and inverted bucket, closed float, float-and-thermostatic (blast) traps, etc.—forged, fabricated (welded) cast and semi-steel construction. Send your problems to Strong, Carlisle & Hammond Company, Cleveland 13, Ohio. No obligation, of course.

STRONG, CARLISLE & HAMMOND COMPANY
Cleveland 13, Ohio

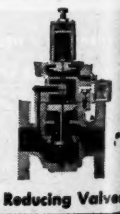
OTHER STRONG STEAM SPECIALTIES



Large Capacity Traps



Inverted Bucket Traps

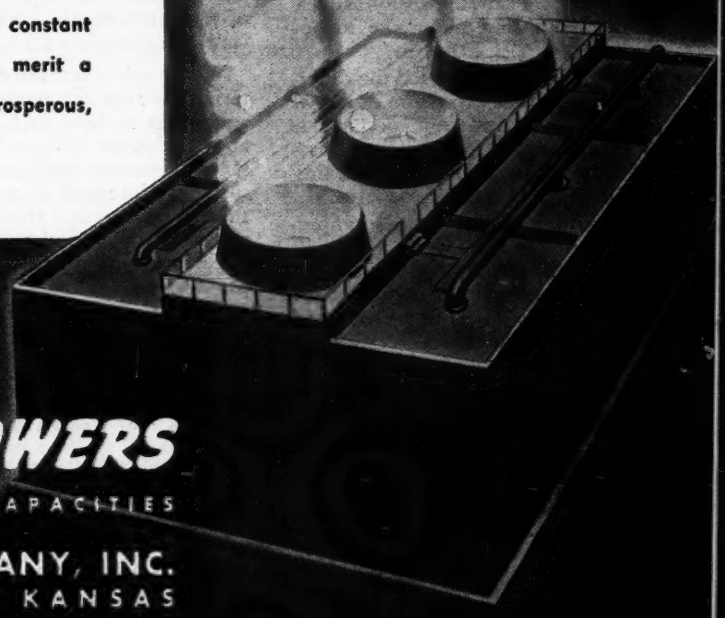


Reducing Valves

To **YOU** *of*
INDUSTRIAL AMERICA:

Merry Christmas *and* A Happy New Year

THE AGE-OLD WISH is repeated with the deepest sincerity by every member of the **MARLEY** organization . . . With earnest appreciation of the patronage which has sent us steadily to the forefront in our field, whether measured by our plants, production and experience or by the size, number and variety of Marley installations . . . With patriotic pride in the part we have been privileged to play toward speeding victory . . . With humble acknowledgment of the obligation to persevere in our program of constant improvement, that we may merit a similar place in creating a prosperous, plenteous post-war America.



MARLEY

COOLING TOWERS

ALL TYPES • ALL CAPACITIES

THE MARLEY COMPANY, INC.
KANSAS CITY 15, KANSAS

OFFICES IN MAJOR CITIES
FACTORIES: STOCKTON, CAL. & KANSAS CITY, KS.

NEW BI-METAL TUBE SHRUGS OFF SCALE

Developed for marine stills to obtain fresh water at sea, self-cleaning tubes offer new advantages for producing feed water in power plants

No mallets, scrapers . . . or hours of hard hand labor . . . are needed to clean this bi-metal tubing. Nor does the evaporator need to be taken down for descaling.

And the heat transfer slow-up produced by a jacket of scale is avoided.

For this tubing shrugs off scale as it works.

Developed for use in an evaporator that obtains fresh water from the sea, it is made by Heat Transfer Products, Inc. (U. S. Pat. 2,279,066.)

The tube itself is made of Admiralty Brass (high heat expansion) with strip of Monel (low expansion) silver-brazed lengthwise along the top of the tube.

When the tube is heated the difference between the expansion of Monel and Admiralty causes it to curve or bow. Contraction from cooling causes it to straighten again. It is this flexing action which shrugs off the salt scale.

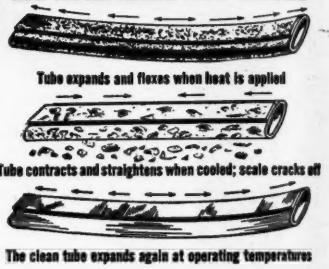
Even ordinary fluctuations in operating steam temperatures crack off some scale continuously. When complete cleaning is finally necessary, the evaporator shell is filled with cold sea water and the tubing is shocked a few times by opening and shutting off the steam flow through the lines. This suddenly reverses the contraction and expansion of the tubes, and the salt cake scales off so that it can be flushed out of the evaporator or pulled out through a cleanout door.

Monel is used to team up with brass in this labor-saving tube because it uniquely combines *all* the properties needed. It is highly corrosive-resistant . . . has 32% lower thermal expansion than Admiralty . . . is readily silver-brazed . . . possesses the strength and resilience to take repeated flexings . . . has good heat transfer properties (important since the strip occupies 20% of the tube's area) . . . and is galvanically compatible with brass.

Where other combinations of materials are required to meet corrosive conditions in heat exchangers, stills and condensers designed for process service, the same type of self-descaling tube may be made by using Inconel tubes with stainless steel (18-8) flexing strips or any other combination of corrosion-resistant materials which provides the necessary difference in coefficient of expansion.

For further information about the tubing that descales itself, address:

HOW THE SELF-SCALING PRINCIPLE WORKS



Tube expands and flexes when heat is applied

Tube contracts and straightens when cooled; scale cracks off

The clean tube expands again at operating temperatures

Cross section of tubing.. Admiralty Brass with strong flexing "Muscle" of Monel

Used in dozens of power applications because of its combined strength, toughness and corrosion resistance, Monel combines with Admiralty to form the self-descaling tubing that shrugs off scale, as shown in the accompanying series of sketches.

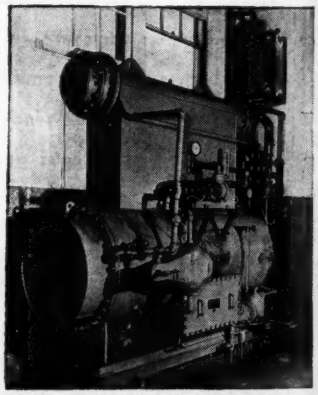


Photo courtesy of U. S. Merchant Marine Academy

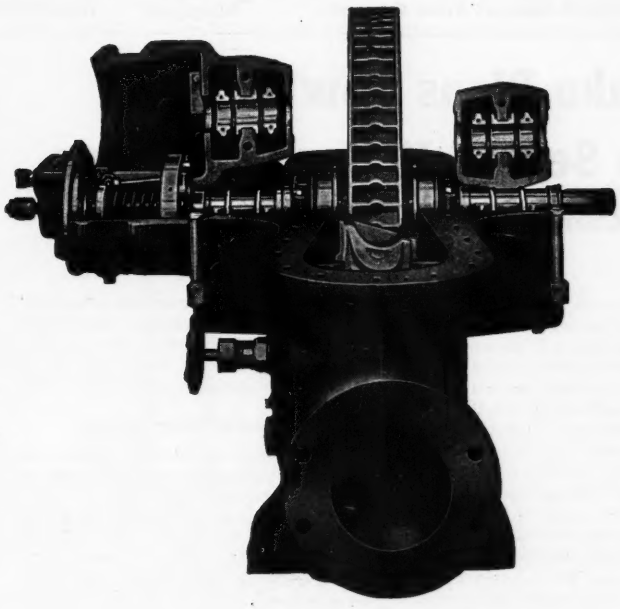
NEW BI-METAL TUBES *shrug off scale in this marine evaporator, made by the Heat Transfer Products, Inc., 90 West Street, New York, N. Y. It produces 50 tons of fresh water daily from the sea, but the self-descaling tubes make unnecessary the slow costly removal of scale by hand . . . assure continuous fresh water supply . . . increase operating efficiency of still.*

THE INTERNATIONAL NICKEL COMPANY, INC. • *67 Wall St., New York 5, N. Y.*

NICKEL INCO ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)

TERRY



ROTOR AND BUCKETS ALL IN ONE PIECE

In the Terry Turbine the wheel is made from a single forging of special composition steel. The buckets are milled directly in the wheel, there are no parts to become loose or work out, such construction makes for long life and low maintenance.

This and many other features of Terry Wheel Turbine design are described in our Bulletin S-116. A request on your business letterhead will bring a copy.

T-1138

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS — *Headquarters for BRASS, BRONZE, and COPPER*

Make Plans Now to Meet More Severe Water Conditions

More Corrosion Resisting Alloys Available

The problem of water pollution by sewage, chemicals and industrial wastes, which already is a serious factor in the operation of power plants, will be worse in the future. As population centers increase and American industry expands with the development of new products and processes, still more mills, factories and shops will be built. As chemistry continues to play an increasingly important part in industry, there will also be a greater number of chemical and process plants. Since most plants are located on harbors, estuaries, rivers and inlets from which power plants draw water for their surface condensers, the power plant engineer is most vitally concerned with water pollution.

Many communities are accomplishing much in sewage processing, and a number of manufacturers are treating and controlling industrial wastes. However, it is not likely that all water pollution problems will be completely solved so far as power plants are concerned. Fortunately, corrosion research and better manufacturing methods have led to the development of new and better condenser tube alloys with superior corrosion resistance. Alert power plant operators, in anticipation of more severe polluted water conditions in the future, are investigating the newer alloys.

Causes of Tube Failure

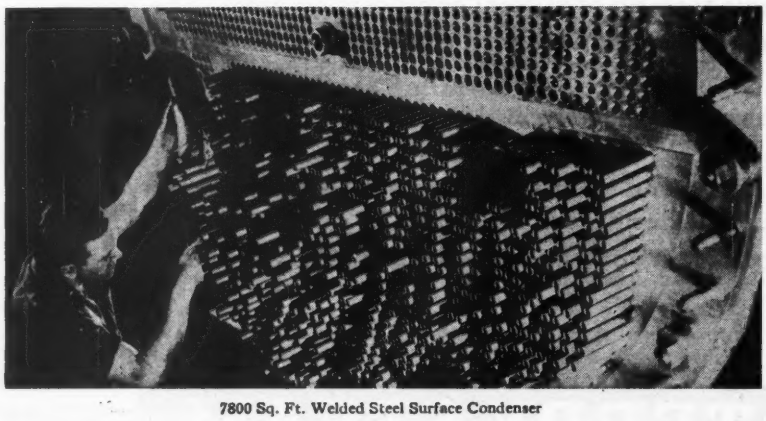
Brackish waters polluted by sewage and industrial wastes have always constituted a serious condenser tube problem. Examination of some of the specific factors involved when condensers operate under such conditions reveals why ordinary alloys fail prematurely. Roughly, these factors may be said to come under one or more of the following categories:

1. Chemical
2. Mechanical
3. Organic

From the chemical standpoint take, as an example, manufacturing plants which discharge an excessive amount of acid wastes into water which is not sufficiently diluted. Acid content of the water can be quickly raised to a point where pit corrosion will be greatly accelerated in the condenser tubes through which such water flows. The presence of chlorides or sulphates in the water will have the same effect.

Under the heading of mechanical factors would come cinders, sand, mud, wood, stones, or other small particles, which are very likely to cause deposit attack as they lodge in various parts of the condenser tubing. On the other hand, large pieces of foreign matter may lodge in the tubes, causing turbulence at those points with resulting impingement attack.

With sewage and organic wastes, hydrogen sulphide, carbon dioxide, ammonia, and nitrogen can cause excessive corrosion and pitting.



7800 Sq. Ft. Welded Steel Surface Condenser

Tests Prove Duronze IV Superior

For some time the superiority of DURONZE IV condenser tubing under such conditions has been recognized. This alloy has been tested side by side with Cupro Nickel, Aluminum Brass and Admiralty by a seaboard power station using brackish water polluted by industrial wastes and decomposed sewage. At the end of nine months both the Admiralty and the Aluminum Brass were severely attacked by pit corrosion and were considered as unsatisfactory for service. The samples of DURONZE IV and Cupro Nickel were left on test for eight months more. After a total of seventeen months' service the Cupro Nickel had thinned to a marked degree and in some places was pitted through. The DURONZE IV showed very little effect and was still in excellent condition after this severe test. DURONZE IV is excellent for seaboard power stations, outlasting both Aluminum Brass and Admiralty. It is especially recommended for tropic waters too severe for ordinary alloys.

Make Plans Now

To help power plant operators who anticipate more severe conditions we will gladly send our Condenser Tube Manual which contains specifications for modern condenser tube alloys, corrosion research data and helpful information.

Be sure to write for your copy. Our laboratory will be glad to help you with problems of excessive tube failure or in planning for the future.

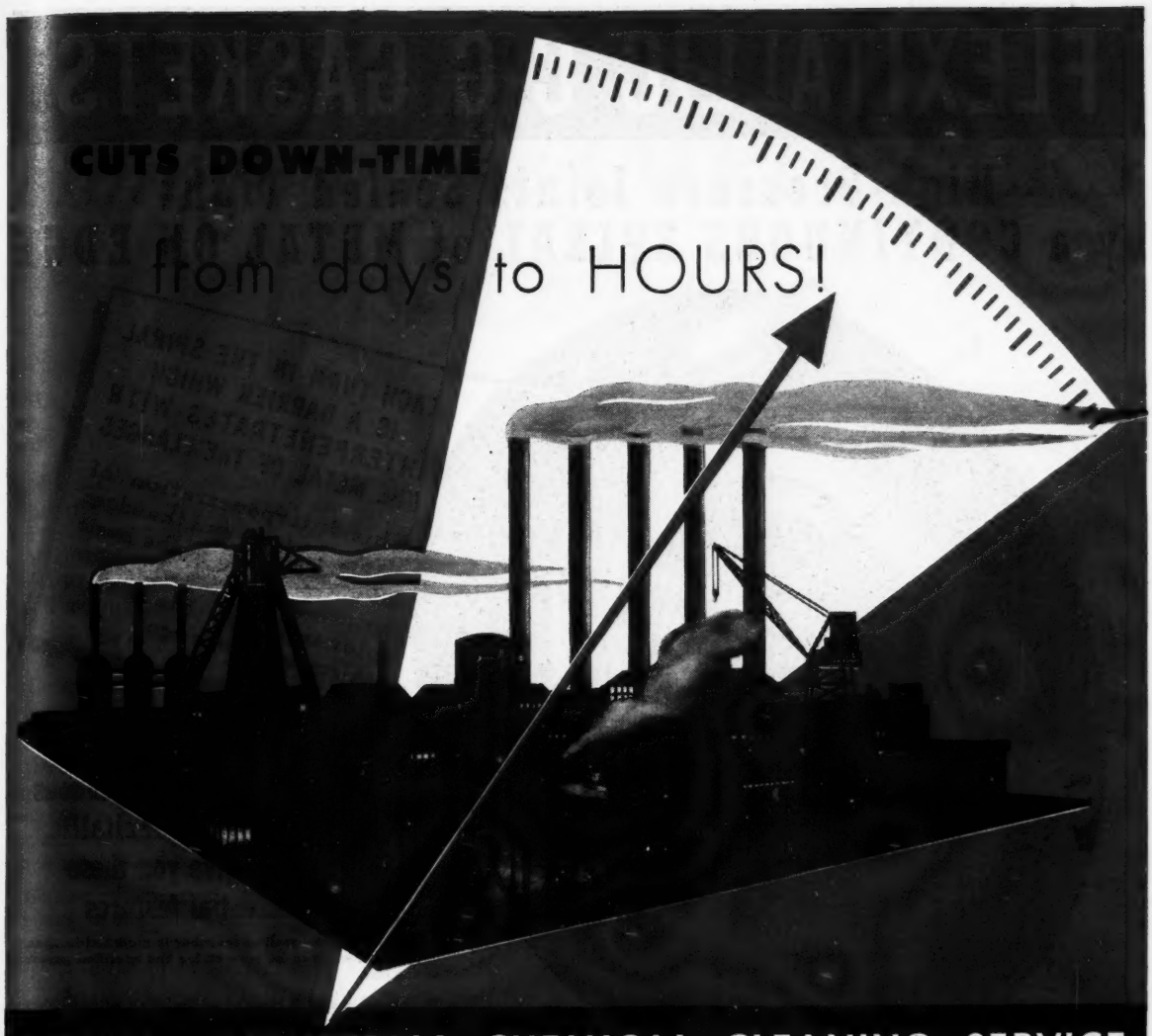
Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

ARMY E NAVY

ESTABLISHED 1865



DOWELL INDUSTRIAL CHEMICAL CLEANING SERVICE

Water- and steam-deposited scale and sludge, thieves of vital power production, now are removed in *hours* of down-time . . . through Dowell Chemical Cleaning.

This notably faster re-energizing service not only saves valuable time and expense, but does so with complete safety to heat exchange equipment. There is no dismantling. After careful analysis, specially adapted solvents are applied by trained engineers in charge of mobile pumps and apparatus.

Dowell Chemical Cleaning Service is readily available at centers of industry in many states. It is a modern chemical development—made possible by close Dowell cooperation with its parent organization, The Dow Chemical Company.

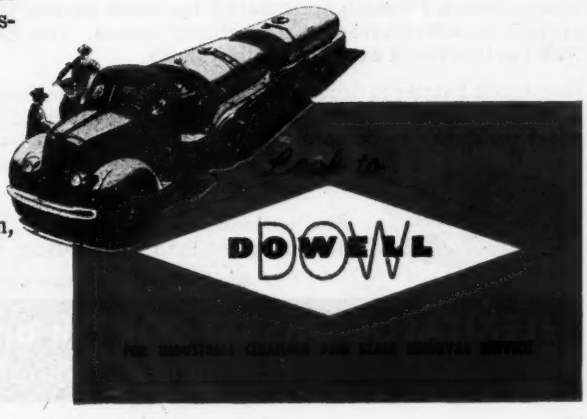
DOWELL INCORPORATED

Tulsa 3, Oklahoma

Subsidiary of The Dow Chemical Company

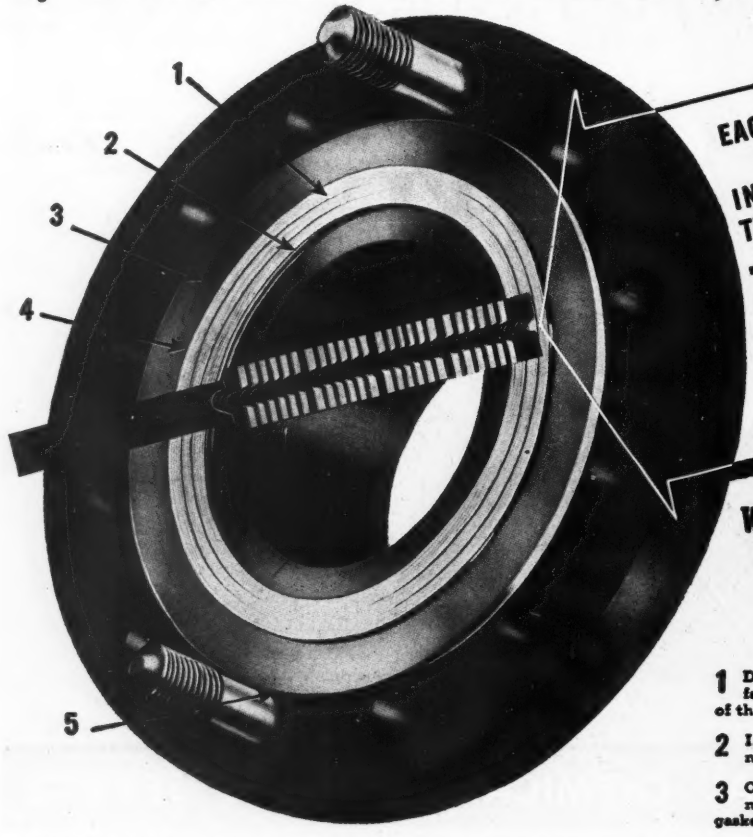
Contact Dowell's Nearest Office for Complete Information

New York • Philadelphia • Cleveland • Chicago
St. Louis • Kansas City • Houston • Long Beach
Salem, Ill. • Wichita, Kan. • Casper, Wyo.
Mt. Pleasant, Mich.



FLEXITALLIC C-G GASKETS

High-Pressure Joints Sealed Tight by a CONTINUOUS SPIRAL of METAL ON EDGE



EACH TURN IN THE SPIRAL IS A BARRIER WHICH INTERPENETRATES WITH THE METAL OF THE FLANGES

This interpenetration of flange surfaces and the edges of gasket metal is the basic principle of gasket design pioneered by Flexitallic thirty-two years ago.

Think of a joint in a steam or other fluid line not as a static assembly but as a moving thing—expanding, contracting, vibrating. Think of the gasket in the joint as a moving member, capable of adjusting itself, always locked to the flange faces in millions of intergranular penetrations. Seen in this way, interpenetration is a starting point, a foundation on which to build a gasket structure.

But how keep the penetration when the flange faces move? In the design, which Flexitallic originated, the metal barrier is formed to provide an active spring, a semi-elliptic crease. The gasket stays with the flanges in every move they make.

How much barrier to provide? This is a vital point in the art. There must be enough to confine the fluid yet not so much as to offer too great resistance to compression and possibly cause overstress of bolts. Flexitallic gives the correct barrier for the specified conditions.

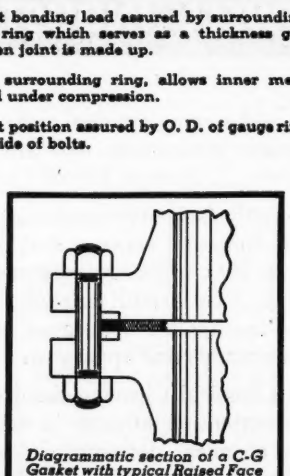
"Flexitallic" Reg. U.S. Pat. Office

And we make setting-up easy. These C-G gaskets with their gauge-ring save time.

Representatives in Principal Cities

With the principle of continuous edge penetration Flexitallic C-G Gaskets give you these other essential features

1. Density of the sealing member is modified in manufacture so as to be correct for the specified pressure of the line.
2. I.D. of gasket is clear of orifice at all points, offering no impediment in line.
3. Correct bonding load assured by surrounding solid-metal ring which serves as a thickness gauge for gasket when joint is made up.
4. Fit of surrounding ring, allows inner member to expand under compression.
5. Correct position assured by O. D. of gauge ring which fits inside of bolts.



Diagrammatic section of a C-G Gasket with typical Raised Face fittings showing the flanges compressed to the thickness of the solid metal member.

FLEXITALLIC GASKET CO., 8th and Bailey Streets, Camden, N. J.

Originators of Spiral Wound Construction

[PUMP TIPS FROM ALLIS-CHALMERS—ONE IN A SERIES]

How to make IMPELLERS Last Longer . . .

CLEARANCES between moving and stationary parts in a centrifugal pump are very small. And when pump and its driving motor are not correctly aligned or weight of piping puts undue strain on casing, every revolution of the shaft throws tremendous extra load and extra wear on all moving parts.

In the case of pumps designed with wearing rings which are attached to the casing, misalignment causes greatly accelerated wear on both rings and impeller — reducing the effective life of both.

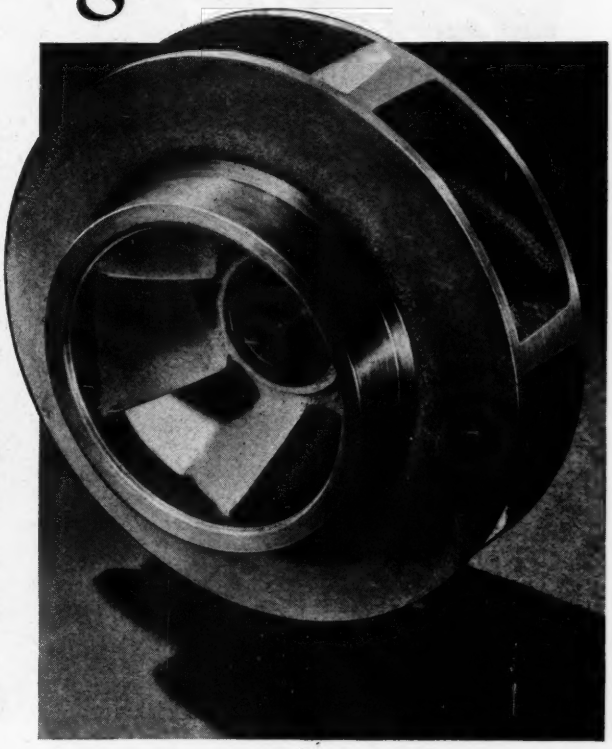
In an effort to eliminate the misalignment problem, A-C engineers developed, for many applications, the "Electrifugal" pump — in which *both* impeller and motor are mounted on *one* shaft and in *one* frame. In such a pump the elements cannot get out of line. Result: wear on all moving parts is greatly reduced.

Besides misalignment, there are still other factors contributing to impeller wear. Regardless of type of pumps you have, here are a few tips which can help you get longer life out of impellers . . .

▸An often overlooked cause of impeller wear is cavitation. For if pump capacity, speed, head and suction lift aren't figured properly, cavitation can eat an impeller away fast. Here's what happens: Rapid movement of impeller blade through liquid produces a cavity behind blade; local high pressure increase drives liquid into metal with terrific force! Moral: Be sure head is right for your pump.

▸If foreign matter is being sucked into your pump it can clog or wear impeller unduly. Where this condition exists, provide the intake end of suction piping with a suitable screen.

▸When you dismantle your pumps (at least once a year), inspect impellers. If they are damaged or blade sections are corroded replace them, but *first* make a thorough search into the possible *causes* for the condition.



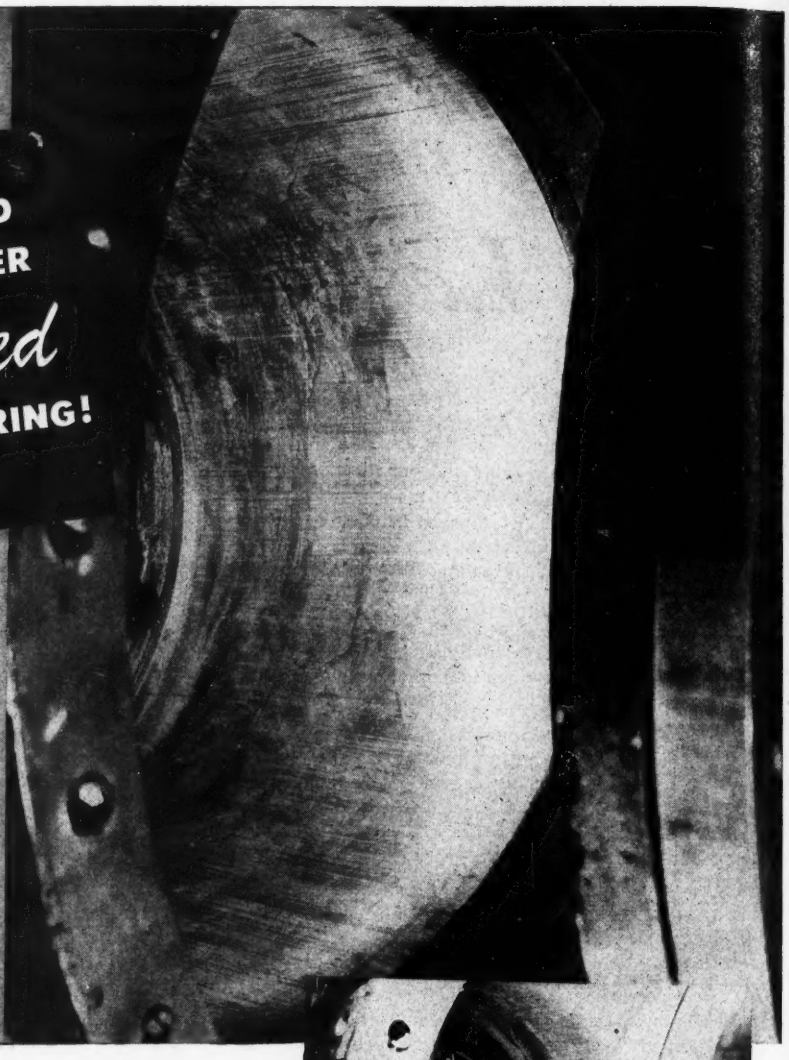
Impellers for Allis-Chalmers "Electrifugal" pumps are supplied in bronze, stainless steel, monel metal or other materials — depending upon the *exact nature* of the liquid to be pumped.

▸If you haven't already done so, send for your *free* copy of "Handbook for Wartime Care of Centrifugal Pumps". This valuable booklet is packed with worthwhile information. Applies to *all* makes of pumps; contains *no* advertising. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 1688

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.

BADLY SCORED AIR PUMP LINER *Smoothed* WITHOUT REBORING!



HERE'S THE ANSWER

Inspection showed the liner of the 24 inch air pump on a U. S. warship to be very much corrugated and scored. There was no time for reboring or replacing liner. Engineers decided to install Sea-Ro Style No. 528 "graphitized" rings, even against our recommendation. This was on April 23, 1943. Few months later a quick look showed liner clearing up. On July 31, 1944, liner and ring were examined. Unretouched photo here shows result. A smoothed liner. Ring wear less than .050 inch and still in perfect condition!

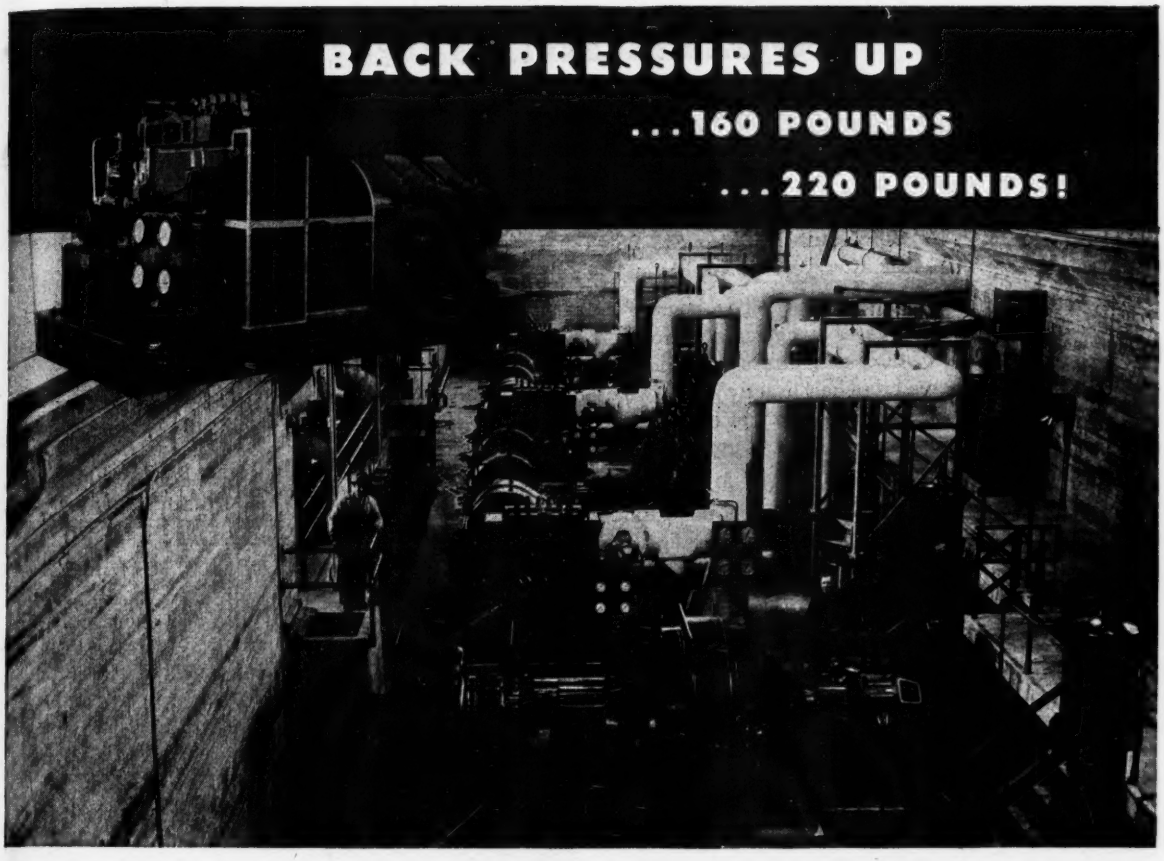
Marine and power plant engineers! Even though Sea-Ro rings are not recommended for smoothing cylinder walls, this unusual case history does illustrate the exceptional smooth-wearing qualities of Sea-Ro rings and toughness of its construction. Friction and wear on cylinder walls are reduced because (1) contact with liner is maintained by the natural resiliency of ring itself; (2) although ring is of exceptionally strong laminated plastic, it is also "graphitized." In effect, it is self-lubricating. Investigate the many other advantages of Sea-Ro rings. They are especially recommended for the "tough jobs" where high temperature and pressure exist. Full details on request.

In operation on this same air pump, Sea-Ro Style No. 535 pump valves continue to give trouble-free, dependable service.

SEA-RO

PUMP PLUNGER RINGS
NEK-SEAL PACKING

SEA-RO PACKING COMPANY • WOOD-RIDGE • NEW JERSEY



Result: Lowest power costs at new synthetic rubber plant with Worthington-Moore turbines

In Canada's new government-owned synthetic rubber plant, operated by Polymer Corporation, Ltd., Worthington-Moore high back pressure steam turbines have permitted considerable savings in power costs. In this, Canada's largest steam plant installation, engineered by H. G. Acres and Company, power is produced as a by-product, since all exhaust steam is used for plant operation.

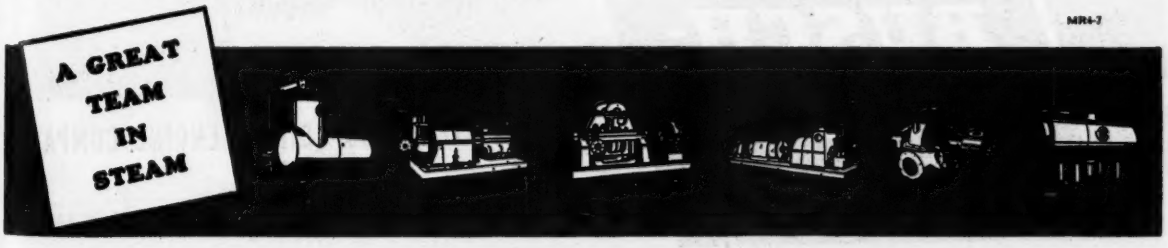
Three Worthington-Moore 1650-hp. geared multi-stage turbines are illustrated above as installed. These topping turbines operate with steam at 400 lbs. initial pressure, 650°F. temperature, and exhaust against 160 lbs. back pressure. Two 1000-hp. Worthington-Moore turbines, exhausting to 220 lbs. back pressure, were also selected.

Save Money In Modernizing Steam Plants

Worthington-Moore turbines operating against unusually high back pressures have enabled many plants to install modern high-pressure boilers without scrapping existing low-pressure apparatus. Write for complete details. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, New York.*

BEHIND THE NAME
WORTHINGTON
MOORE

MR4-7



Constant Hair-splitting to give you Constant Performance

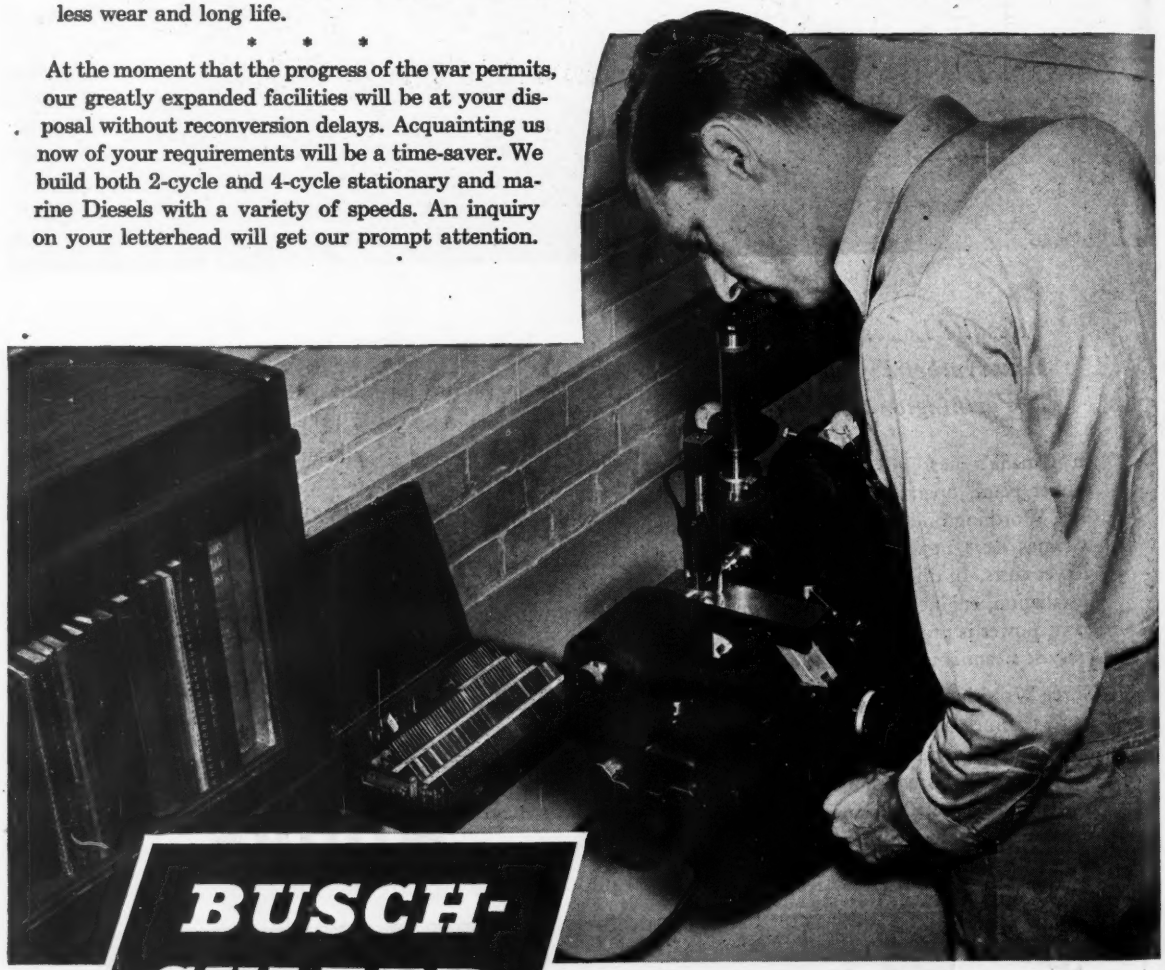
The great part that close tolerances play is one of the reasons why Busch-Sulzer Diesels are noted for their ability to give year after year of reliable and economical service.

For example, every eight hours, when a new shift reports, all gages are given a microscopic examination capable of disclosing errors in millionths of an inch. Only when a cross-hair exactly splits two other cross-hairs is the gage under examination up to Bureau of Standards specifications and ready for work.

This hair-splitting precision plus the skill of America's oldest builder of Diesels has resulted in engines famous for their simplicity of design, which makes for fewer moving parts, better lubrication, less wear and long life.

* * *

At the moment that the progress of the war permits, our greatly expanded facilities will be at your disposal without reconversion delays. Acquainting us now of your requirements will be a time-saver. We build both 2-cycle and 4-cycle stationary and marine Diesels with a variety of speeds. An inquiry on your letterhead will get our prompt attention.

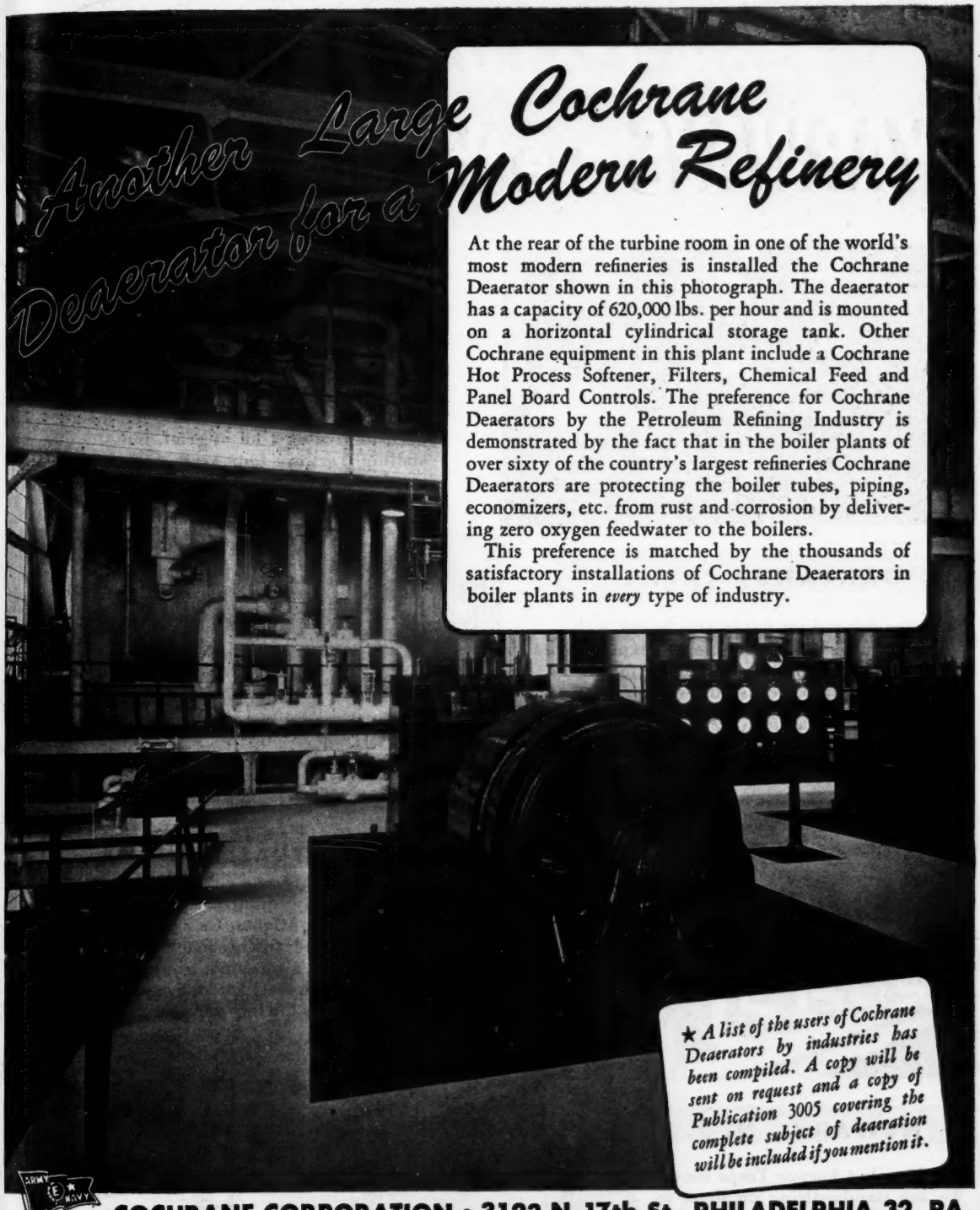


By actually splitting two tiny cross-hairs with a third cross-hair, this microscopic inspecting instrument puts the O. K. for accuracy on the many gages used in Busch-Sulzer's close tolerance work.

BUSCH-SULZER
ST. LOUIS

BUSCH-SULZER BROS.–DIESEL ENGINE COMPANY
SAINT LOUIS

America's Oldest Builder of **DIESEL ENGINES**



Another Large Cochrane Deaerator for a Modern Refinery

At the rear of the turbine room in one of the world's most modern refineries is installed the Cochrane Deaerator shown in this photograph. The deaerator has a capacity of 620,000 lbs. per hour and is mounted on a horizontal cylindrical storage tank. Other Cochrane equipment in this plant include a Cochrane Hot Process Softener, Filters, Chemical Feed and Panel Board Controls. The preference for Cochrane Deaerators by the Petroleum Refining Industry is demonstrated by the fact that in the boiler plants of over sixty of the country's largest refineries Cochrane Deaerators are protecting the boiler tubes, piping, economizers, etc. from rust and corrosion by delivering zero oxygen feedwater to the boilers.

This preference is matched by the thousands of satisfactory installations of Cochrane Deaerators in boiler plants in *every* type of industry.

★ *A list of the users of Cochrane Deaerators by industries has been compiled. A copy will be sent on request and a copy of Publication 3005 covering the complete subject of deaeration will be included if you mention it.*

ARMY (E) NAVY

COCHRANE CORPORATION • 3123 N. 17th St., PHILADELPHIA 32, PA.

COCHRANE

SOFTENERS • DEAERATING SOFTENERS • DEAERATORS • METERS • STEAM SPECIALTIES

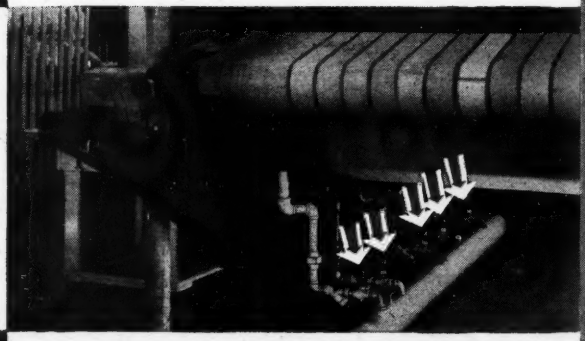
From Coast to Coast...
YARWAYS are the Trap Choice

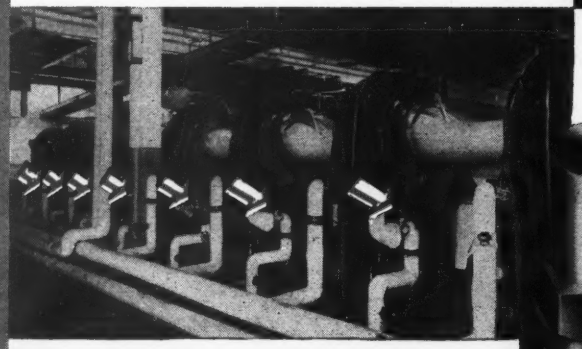
DETROIT, MICH.

"After I saw how well YARWAY Impulse Traps settled the trouble we had with an ironer, I extended their use throughout our laundry. These dry tumblers, for instance, used to give us a lot of grief, but since installing Yarways four years ago, I haven't touched either tumblers or traps."

OAKLAND, CALIF.

"Our machines heat faster, stay hotter with Yarway Traps. They save time and expense. There are no idle units—no waiting for machines to heat up because these traps open wide for heavy condensate loads, operate intermittently for light loads."



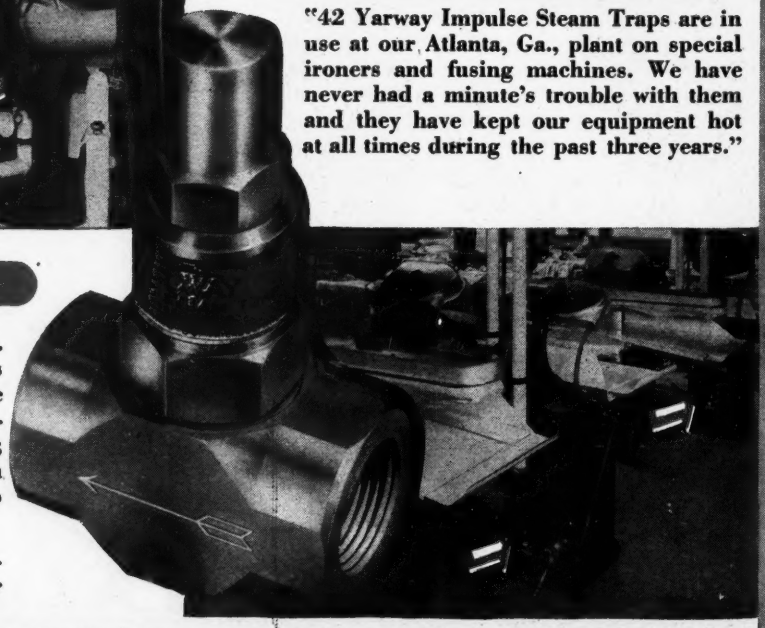


ATLANTA, GA.

"42 Yarway Impulse Steam Traps are in use at our Atlanta, Ga., plant on special ironers and fusing machines. We have never had a minute's trouble with them and they have kept our equipment hot at all times during the past three years."

NEWARK, N. J.

"Nothing but Yarway Traps for us. We are standardizing on them as fast as other traps wear out. We like them because we can get maximum temperatures in our units; their small size leaves more room around machines, and they are so easy to install and maintain."



Why not end your steam trap troubles? See your Mill Supply Dealer —or write for Catalog T-1739.

YARNALL-WARING COMPANY, 114 Mermaid Ave., Phila. 18, Pa.

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Industrialization of South America

By NELSON A. ROCKEFELLER

IN ALL THE WORLD only 500 million people could be called paying customers. Yet on this globe there are, in addition to that fortunate half billion, 1,500,000,000 other human beings who, though they live in lands with resources and are able and willing to work, are frozen into a mold without opportunities. They are not buyers. They could be.

Supplying the needs created by this new world standard of living would help us, who live in the United States, provide employment and opportunity for all and an assurance of an ever higher standard for ourselves. How to do all that? By helping in the industrialization of other countries, starting right here and now with our Central and South American neighbors. This will place them in the same mutually beneficial relationship to us as we are to Canada.

Throughout this war, the people of Central and South America have joined with us to defeat our common enemy. The unity which has followed from working out our mutual destiny has been unparalleled in history. We are deeply indebted to our neighbors.

The end of the war will open up a broad many-laned highway which leads to mutual strength and prosperity. The foundation has been laid in the unity which we achieved during the war. This unity has been for mutual defense, so that together we could destroy the greatest menace which ever challenged the democratic way of life anywhere. Now it is time to hope and to think about the mutual benefits of continuing unity, for from here on out it is unity for construction, unity for the building of a peaceful and prosperous hemisphere, which challenges us.

Facing up to this new job means looking squarely at all the facts. The first and foremost question is that of industrialization, for that is the controlling factor in the world standard of life. Every country south of us urgently wants industrial expansion. Industrialization has made us strong, and any program now to be undertaken for the future must have as its fundamental the continual growth of a prosperous United States. That is the essential ingredient to our position in the changing pattern of the world.

Hemispheric industrialization fills this bill. It is properly part and parcel of a global pattern for keeping the peace and for making people strong. Their wants, their well being, and their ability to enjoy fullest opportunities all are implicit. As we help achieve this, so will our business men, workers and farmers prosper, for they will be selling more of their production, helping to stabilize domestic employment, farm prices and profits.

In some countries of Central and South America great progress toward industrial development has been made; in others it is just beginning. The people and the leaders of these republics have already accomplished much, but there is also much that a good neighbor can do to help. They realize that each industrial gain will create for them and for their neighbors a whole circle of widening opportunity. Generally all the southern countries want a program of added roads, mechanized farms, of factories and of institutions. They will start with fundamentals—Agriculture, Chemistry, Manufacturing, Metallurgy, Power, Coal, Petroleum, Transportation and Housing. In all of these, we are in a strategic position to help, for we lead the world in just these fields. Our job is to assist in their plans, furnish the equipment and skills, and the capital where needed, with which to make their plans and hopes for themselves come true.

Participation in the planning for the industrial development of our southern neighbors offers in itself a new and exciting field of enterprise, for helping them involves not only blue-printing, design and sale of equipment and machinery but help in the organization of many millions of man hours, the product of which will in turn eventually carry the cost of the new ventures. Resources and manpower will be made productive with the help of power and machinery. It is easy to visualize the developing market caused by the resulting increase in the general purchasing power. Good business? Yes. But more, the solidest kind of proof that we have done a sound job for the largest number of people in both the country we help and in our own.

What will we sell? Consumer goods, of course. But that, though sales will probably be larger than prior to the war, need be only a small part of the whole. An important source of employment here should come from selling to Central and South America industrial equipment, transportation and communications equipment, and from the greatly accelerated export of engineering and management skills. We have already started down this road of interchanging technical and professional knowledge. Our neighbors are sending many of their sons and daughters to this country for education in our engineering schools. This is one of the newer exchanges which promises so well and it is only the beginning.

Naturally, our sales of heavy industrial equipment would sharply rise, and just as naturally our sales of finished articles would also rise. Almost the first thing which each of our neighbors wants to do is increase its food production so that more of the population will enjoy the fruits of better nutrition. For that they ardently want to set up the plants for making agricultural machinery. Because of limited skills and capital, many of their factories will be small and will probably produce only a few units a day. Yet any plan for farm mechanization will call for thousands of varied units, most of which we can supply.

On another of the industrial fronts allied to farm mechanization, a great field opens up for the design and manufacture of simple machinery for small communities, so that they, in their villages, far from industrial centers, can make maintenance equipment.

Every step upward on the expanding scale of industrialization in this hemisphere will open up a new opportunity for people to satisfy long unfilled wants. Each is an opportunity for us as it is for them. As we produce more to satisfy their needs, our own skills and know-how will continue to evolve and grow more perfect. Our practices grow better as our opportunities expand. In the augmented production which will result from the industrialization undertaken by our southern neighbors lies also the secret of expanding economic activity in these countries coupled with rising employment and opportunity for all.

On a money basis it makes sense, and at the same time all of the funds invested help in building security for as against war by creating even stronger bonds of unity among all the nations on this hemisphere—with each one expanding, each more prosperous.

We can be good neighbors with this policy—good neighbors in the best sense of democracy, of the forward looking, helpful cooperation which is the need of our time.

Copyright 1944 BNS

NELSON A. ROCKEFELLER is Co-ordinator of Inter-American affairs. He needs no introduction to American business men. The family of which he is a most active member has successfully produced and sold a wide variety of commodities ranging from oil to entertainment. It is with this background that Mr. Rockefeller approaches the important problem of our economic relations with South America. He has prepared this article, through Business News Service, exclusively for POWER PLANT ENGINEERING and other BNS members.

COMPRESSED AIR GEYSER

Those who have had an opportunity of visiting Yellowstone National Park and seeing the geysers in action there will be reminded of these spectacular natural eruptions by this photograph. This also is a geyser, but it is not a natural one. It is man-made. It is the water discharge from the underground chamber of the hydraulic air compressor at the Victoria Copper Mine near the Village of Rockland, in northern Michigan. As described more fully in an article by Paul Ziemke on page 77 of this issue, this is one of the only two compressed air installations of this kind in America. Hydraulic air compressors of this kind can only be used where sufficient hydraulic head is available and where there is use for large quantities of compressed air. This was the case at the Victoria Mine. The presence of a large waterfall led the engineers on the project to investigate the possibilities of supplying the large quantities of compressed air needed in the mining operations, directly from the fall of the water and in 1906 construction was begun on what is known as the Taylor compressor. The method by which water is used to compress air in such systems is described in Mr. Ziemke's article. It may be thought of as something like the reverse of the air-lift used in many places to pump water from underground sources. In such air-lift systems, compressed air is used to pump water. In the hydraulic compressor, water power is used to compress air. Such natural hydraulic compressors operate with relatively high efficiency.

WITH THE EDITORS

◆ **Frankenstein's Monster?**—When the "typhoons" of industry talk about the achievements of industry during the war, they little realize that they may have created a Frankenstein's monster in the form of a technical and scientific organization they cannot control.

Right now industrialists are all up in arms over strikes by groups of foremen and technicians. They want these groups to regard themselves as part of management, rather than as "labor." And when these groups form unions and try to secure redress of grievances, whether legitimate or not, the owners of industry utter loud cries of anguish. This is rank betrayal! they cry, and it is due to the pernicious policies of the New Deal, in which That Man has "coddled" labor and encouraged it in all sorts of "unAmerican" activities.

The latest occurrence of this kind was a three-day strike of less than 2800 members of the Wright Aircraft Supervision Association, which forced 32,000 production workers into idleness in five plants of Wright Aeronautical Corp. It threatened a delay in the production of B-29 bomber engines and aroused much concern in industry. If supervisory employees are no longer to be considered part of management and are to have the bargaining rights and power of labor, what of the engineers in industry? Are they, too, going to become infected? What is the meaning of the discussions now going on even in the august halls of the venerable ASCE and other engineering societies? Is there any possibility that the "managerial revolution" predicted by Burnham will become a fact? Horrible thought! The engineers and technicians are the ones who have the "know-how" that makes industry run. Could they not, by using their collective power, actually control industry?

To hear many engineers talk, you'd think they were bloated bondholders, economic royalists of the first water. With the utmost conviction, they utter every one of the outworn economic clichés of a system of finance capitalism that no longer exists. Yet many of them, when they examine their social and economic status, observe that most industrialists regard them as so many brains to be used. "Engineers are a dime a dozen," except during the war, when they are scarce. In peace times, the engineers' only hope of security for themselves and their families is in the existing industrial system and, looking forward, they are none too sure of that.

Engineers feel they are being forced, against all their natural inclinations, to think about letting themselves be unionized and sacrificing some of their professional status in order to have an economic weapon against real or fancied exploiters. And if they ever do that *en masse*, the existing industrial system is destined for important changes.

◆ **Shibboleths**—Industry has always recognized what a serious threat the professional spirit of the true scientist and engineer can be to all its commercial shibboleths. Nevertheless the engineer has always allowed himself to be convinced that he must always compromise between what is best scientifically and what is best economically—best for somebody else. If industry made no profits, who would pay the engineer's salary? Yet what engineer has not encountered important situations in which the best engineering procedure has had to give way before the question "But who'll pay for it?"

◆ **Turning Them Loose**—But now he observes that by turning the engineers loose, without regard to profits, Germany showed what could be done for evil purposes of world mastery that we are fighting to destroy. Incidentally, she also showed that turning the engineers loose necessitated the destruction of all semblance of a freely-competitive, free-enterprise industrial system. American industry, during the war, has had to turn its engineers loose to combat the evil but with much the same result.

After the war, engineers will have to be put under wraps again and made to realize that, after all, *they* don't own the economic system nor determine its policies. They are merely hired to make it run. Will they accept this after having had a small taste of freedom to let themselves go? Or will they decide to drop their professional dignity and use union methods?

Personally, we don't think they will. Engineers don't realize how the nontechnical "typhoons" regard them, even while they pay lip service to technology. Engineers see a prestige in their professional standards that industrialists don't recognize. But engineers have an uneasy feeling that perhaps organization might do for them what it has done for labor. Right now, with labor sitting pretty, the advantages of union organization look attractive to many engineers. But labor unions' numerical strength will drop 50 per cent overnight at war's end; will they then hold their present strategic power? Will there be a greater tendency after the war for industry to resist very strongly the pressure of labor unions?

◆ **One Big Union?**—Many engineers voice the opinion that, to fit future conditions, one large national association of all engineers, with high professional standards, would better fit our much-altered conditions than the large number of smaller engineering societies or than split-up affiliations with organized labor. They argue that such a common association would have sufficient numerical strength and enough common purpose to make its influence felt nationally, both in industry and in politics.

Interest in the idea has reached such a point that C. A. Powel, new AIEE president, could discuss it publicly at a recent Los Angeles section meeting. For some time, too, the ASCE and the ASME have had committees studying this whole question. It is just another symptom of the engineer's recognition that to survive he must have a program and a voice strong enough to resist the pressures on him from both industry and labor. He is both capital and labor, but he is also more — he is intellect. And it is a truism that society has always paid more in money and recognition to its masters and entertainers than to its intellects. The engineer and the scientist work primarily for truth. They think it's more important than money. Has the time come when they will resist effectively the pressures upon them from above and below?

◆ **Frankly, we doubt it.**—Engineers have many conflicting purposes as well as honest differences of opinion. Their leaders are so tied into the industrial system by financial, personal and ethical bonds, that we doubt very much if engineers as a group will ever break away from them. They must be loyal, must never bite the hand that feeds them. If they could, they have the knowledge and power to take over control of industry at any time. Whether that would be a good thing for society, we also presume to doubt.

But there is little danger of it. Engineers have been too well trained in the belief that if they work at low hourly wages preserving their professional attitudes with prayer and fasting in the shrines of the engineering societies, they will one day be allowed to "rise" out of engineering and become vice-presidents in charge of pencil sharpening. How much better off would they be if they "fell" into the ranks of labor? We don't know; but we venture the prediction that nothing will be done about it by engineers themselves.—C. R. E.

◆ **Surplus Property**—Under a new plan adopted by the Treasury Procurement Division it is going to be easier to inspect and buy surplus property to be disposed of by the Government. According to a recent announcement, in the future, a "Surplus Reporter" will be sent to each person on the Treasury List, explaining what is for sale, where, at what price and under what conditions. The lists are to be broken down into eight general classifications, of which machinery is one. There will be a 15-day lag between the time the Surplus Reporter is sent out and the time the goods is sold so as to allow time for inspection and making bids.

This will be good news for owners of industrial plants who are in need of power plant equipment for which they have not had sufficient priority during the war years. While such lists have not yet been made generally available, it is reasonable to assume that a great many power plant items will be offered for sale. Already we have seen lists offering such items as pumps, motors of various kinds and sizes up to 2500 hp, piping, switchgear, etc.

In most cases, the Treasury is restricting sales at the present time to regular channels of trade, that is, to manufacturers, wholesalers, jobbers and retailers who deal regularly with the particular kind of property involved. So, if you are a power plant owner, it probably will not do you very much good to try to work directly through the Treasury Procurement Division, but it may pay you to keep informed about what dealers and jobbers in power plant machinery are doing. Before very long some of this equipment should be available to plant owners.

Silver Gate Station Powers San Diego for War

By

H. A. Noble

Superintendent of Electric Production
and

W. A. Zitlau,

Station Chief, Silver Gate Station,
San Diego Gas & Electric Co.

As Told to
F. R. SCHALCK
Western Field Representative,
Power Plant Engineering

New generating plant of San Diego Gas & Electric Co. adds 35,000 kw of firm power to system for carrying greatly increased war loads in San Diego, Calif., and surrounding area . . . Single 35,000-kw, 3600 rpm unit, with hydrogen-cooled generator, designed for 8.44 lb steam per kwhr, supplied with 850-psi, 900-F steam by two 200,000-lb-per-hr integral furnace, gas-and-oil-fired boilers . . . Earthquake and blackout construction . . . Steam temperature control by attemperator . . . Outdoor circulating pumps and traveling screens . . . Special cooling water system . . . Simple, compact "one-room" design, for ease of construction, convenience of operation and high economy

SINCE THE beginning of the war, various cities on the Pacific Coast have been confronted with serious problems of public service. Among these, San Diego, Calif., with its huge and rapidly expanding military program, its vast war industries and its swollen population, has been urgently in need of additional utility services. Because of this need the San Diego Gas & Electric Co. began early in 1941, after bringing its Station B plant up to its ultimate capacity of 102,000 kw, the construction of its $4,000,000 Silver Gate steam-electric generating station described below. Designed for an ultimate capacity of 185,000 kw, the initial installation of the new station consisted of a 35,000-kw turbo-generator and two 200,000-lb-per-hr boilers. Despite delays in delivery of several essential items, labor shortages and transportation difficulties, the plant was placed in operation early in 1943.

The company's program also necessitated extensive additions to its tie line system. These included construction of a 25,000-kva substation at Old Town as well as the 50,000-kva Sampson substation, which contains the 12 kv switching equipment for the new Silver Gate generating station. The new substations are important elements in a new loop surrounding San Diego and tie together the company's two steam generating stations and Mission Valley substation, which is just outside the city and is the terminus of a 36,000-kw interconnection with the Southern California Edison Co.

That the company has been able to surmount the difficulties thrown on its shoulders by the tremendous war activity in the San Diego area is evidenced by the honors and citations it has received. For "splendid performance during 1941 in meeting greatly increased industrial and defense loads," the company was awarded the Charles A. Coffin Award, top ranking citation of the electrical industry. In September, 1943, the company received a Naval Citation for "meritorious wartime service"— the first award of its kind on the Pacific Coast. In 1942 and again in 1943, the Gas Division of the company received the "million man hour" award of the American Gas Association for completion of more than a million man hours without a disabling accident.

Earthquake Construction

The new Silver Gate Station is of steel-frame, concrete, earthquake-resistant construction. Design for earthquake stresses was based on a lateral force of 0.2 g which is somewhat greater than the figure in general use on the Pacific Coast. The additional cost of "earthquake design" over ordinary design was

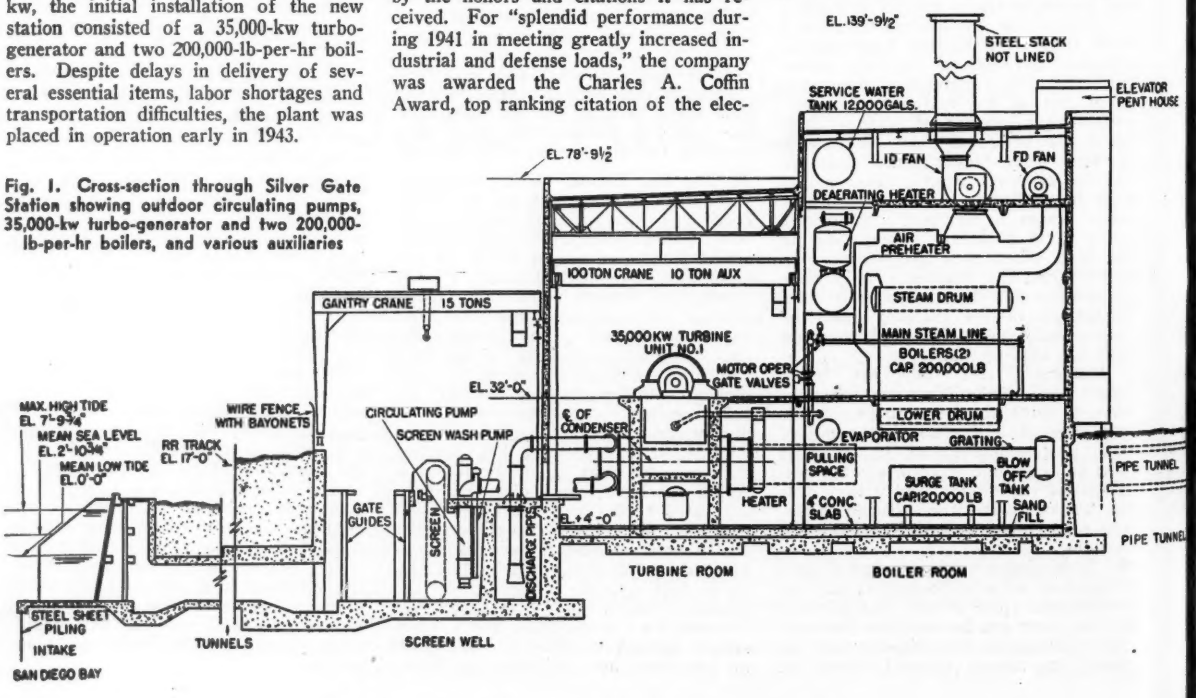


Fig. 1. Cross-section through Silver Gate Station showing outdoor circulating pumps, 35,000-kw turbo-generator and two 200,000-lb-per-hr boilers, and various auxiliaries

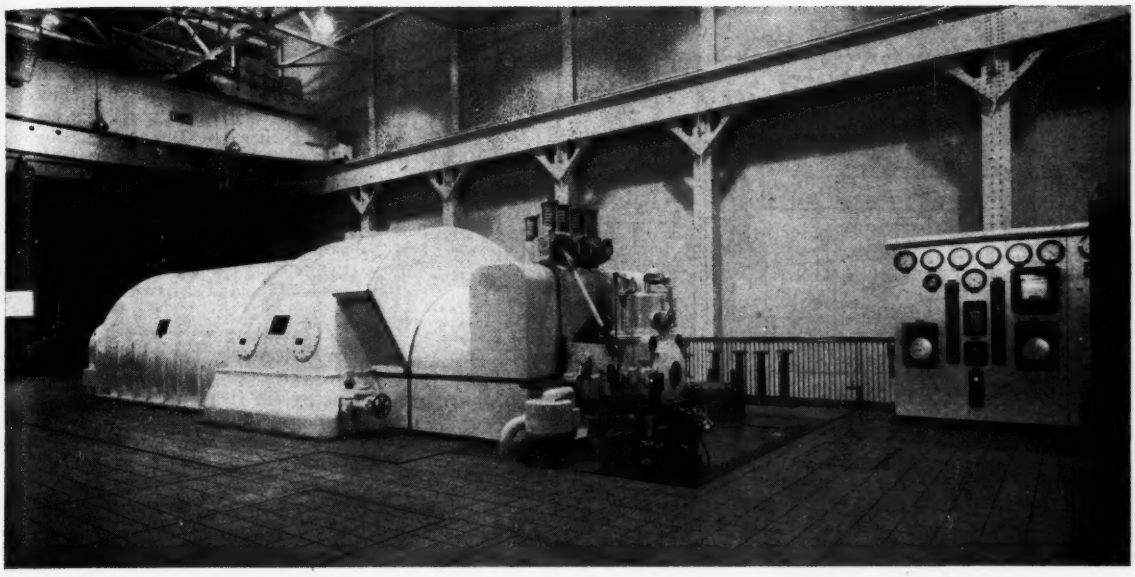


Fig. 2. View of 35,000-kw turbo-generator, with turbine control panel at right

approximately 6½ per cent of the cost of the building and less than 1 per cent of the total station investment.

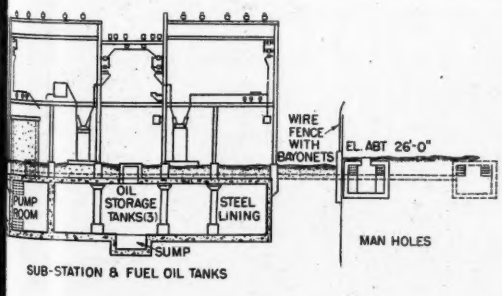
To provide maximum air-raid protection, the power plant proper was constructed without windows. The connecting administration building, which provides office, storeroom and shop space for the ultimate 185,000-kw station, has windows on the two upper floors while the ground floor and basement are windowless. Required ventilation is furnished by three 60,000-cfm fans, the air being conveyed through steel ducts to strategic distribution points. The two unlined steel stacks are equipped with triple aircraft obstruction lights, which can be lowered to roof level for servicing. Conforming to modern practice, the station is of the "one-room" design, with no division wall between boiler and turbine areas. This arrangement promotes a simple, compact equipment lay-out and contributes greatly to convenience of operation and maintenance.

Boilers and Auxiliaries

The two Type F integral-furnace boilers are "low type" units. Their low center of gravity offers advantage in providing for lateral stresses for earthquake design. Each boiler has a capacity of 200,000-lb-per-hr, with a heating surface of 13,450 sq ft, generating steam at drum pressure of 920 psi gage, 900 F. The boilers face the turbine room with boiler controls located on the main operating level as shown in Fig. 5.

The inverted loop convection type superheaters are divided into primary and secondary sections. Total steam temperature is controlled by means of a surface type desuperheater known as an attemperator, which is located outside the boiler setting and is connected between the superheater sections. The superheater outlet design temperature of 900 F is maintained between boiler loads of 75,000 lb per hr and 200,000 lb per hr when on gas fuel, and between 115,000 lb per hr and 200,000 lb per hr when on oil fuel.

Air preheaters are of the horizontal tubular type having a heating surface of 18,000 sq ft, with two gas passes and one air pass. At full boiler load on natural gas fuel, with an initial air temperature of 80 F, they produce a final temperature of 485 F, with a flue gas temperature of 695 F leaving the boiler and 386 F leaving the air preheater. The air preheaters are located over the boiler setting and the gases make a top entry, thus permitting a full length soot hopper. This hopper is connected to a disposal line.



Continuation of cross-section Fig. 1, showing oil storage tanks and outdoor substation

Firing Equipment

Boilers are normally fired with natural gas, with fuel oil as a standby. The fuel is fed by the four combustion gas and oil burners shown in Fig. 4. The oil burners are of the wide range mechanical atomizing type, the system incorporating a centrifugal pump designed to give constant differential oil pressure across the burners from minimum to maximum rating. Fuel oil is stored in three 5000-bbl, rectangular, steel-lined concrete tanks located underground beneath the 12-kv substation adjacent to the station, as shown in Fig. 1. The oil storage and supply system employs the conventional oil strainers, pumps and heaters, the only unusual feature being the constant differential oil pumps, which are located at the boiler fronts on the main floor.

Combustion control for these boilers functions through fuel-flow air-flow and steam-flow-air-flow ratio controllers. The steam pressure is controlled by a master steam pressure recorder-controller. All ratios can be maintained either on automatic or hand control. The system also includes controllers for steam temperature, furnace draft, gas pressure and a 3-element feedwater control. The boiler control board combines vertical and bench type panels as shown in Fig. 5. Both boiler and turbine control panels are well lighted by fluorescent lamps installed in canopies as shown in Figs. 2 and 5.

The induced and forced draft fans are located on the top floor of the plant, Fig. 1. Each boiler is served by a 120,000-cfm double-inlet induced draft fan, driven by a 350-hp motor and a forced draft fan having a capacity of 66,000 cfm, driven by a 200-hp motor. All draft fans operate at constant speed and are provided with vane control.

Heaters and Pumps

Feedwater is pumped to the boilers by three multistage centrifugal pumps, two 1050-gpm and one 600-gpm, each designed for a total head of 2500 ft with a suction pressure of 45 lb. One of the 1050 gpm pumps is driven by a 900-hp motor and the other by a 950-hp steam

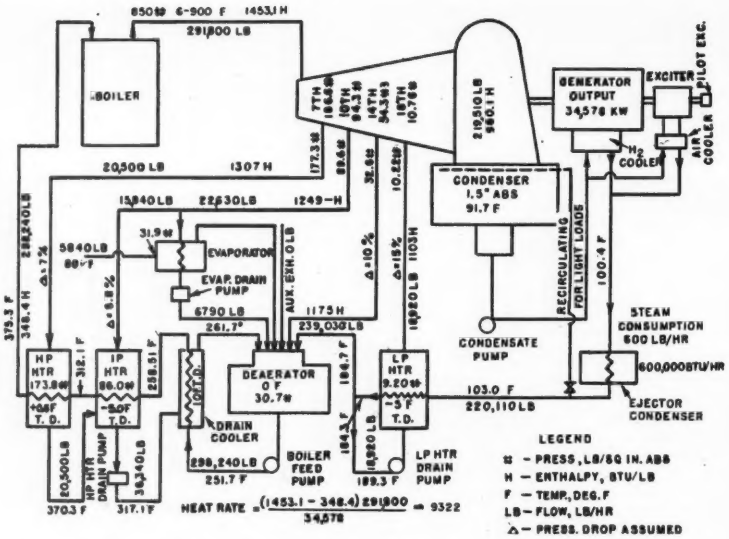


Fig. 3. Heat balance diagram of plant for generator output of 34,578 kw

turbine, the latter serving as a standby in the event of a pump or power failure. The 600-gpm pump is motor driven and operates when the station is on a load of 60 per cent of capacity or less. Each pump is protected at extremely low loads by a bypass control valve. The feedwater heating cycle is shown in Fig. 3.

Turbo-Generator and Auxiliaries

The main operating floor and turbo-generator unit are shown in Fig. 2. Walls, ceiling and steel in this room are painted a flat ivory tan. The floor is of 9-in. quarry tile with black joints. The turbo-generator and the control and instrument panels are cream enamel with maroon base where needed. A large floor hatch permits the 100-ton turbine room crane access to the basement.

The turbine is a 3600-rpm, 35,000-kw, 21-stage double-flow impulse type unit. It is designed for a water-rate of 7.5 lb per kwhr non-extracting, with a throttle pressure of 850 lb and 900 F and an exhaust pressure of 1½ in. Hg abs. While heating its own feedwater, a water rate of 8.44 lb per kwhr is expected. With standard steam conditions, that is 850 lb, 900 F at the throttle, the turbine is designed to carry 43,750 kw with a back pressure of 1.5 in. abs. It will actually carry this load with 2½ in. back pressure and will carry 35,000 kw at approximately 19 in. abs, with extraction for heating its own feedwater in both cases.

The high pressure, high temperature sections of the turbine are cast molybdenum steel. All wheels are machined integral with the shaft, providing a rigid rotor which experience has proved very satisfactory at rotating speeds of 3600 rpm. From the four extraction points shown on Fig. 3 about 25 per cent of the total throttle flow is extracted at full load for feed heating.

The electric generator is a 3-phase, 2 pole, 60 cycle, 12,500 v, 50,000 kva hydrogen-cooled unit, designed for power factor of 70 per cent. The stator frame is of welded plate construction. The stator core is flexibly mounted in this frame to minimize the effects of double frequency vibration. Exciter and pilot exciter are 250 v units driven at 1772 rpm through a single reduction gear from the generator rotor.

Circulating Water

The condenser is a 29,100 sq ft, two-pass divided-flow, horizontal unit. The two circulating pumps are 15,000-gpm vertical motor-driven, propeller-type units.

Circulating water is salt water from San Diego Bay brought to the plant in two concrete intake tunnels approximately 750 ft long and designed for the station's ultimate capacity of 185,000 kw. The traveling water screens and circulating water pumps are located just outside the station as shown in Fig. 1. This is expected to cut down the amount of shells and marine growths carried into the condenser, and to be an improvement over the arrangement at the company's Station B where the screens are at the bay end of 1350-ft tunnels. Marine growths developing in the long tunnels reach the condensers in large quantities at certain times of the year.

The house service water and bearing cooling water system is also somewhat different from that employed at Station B, where salt water from the circulating water tunnels is used for all bearing cooling. This requires a network of salt water lines throughout the plant that are a constant source of high maintenance and trouble due to leakage. In contrast to this, the cooling system at Silver Gate employs treated fresh water and utilizes as makeup certain leakoff and drips which are not considered suitable for boiler feedwater makeup. The warmed fresh water is passed through heat exchangers where salt water is utilized to cool the fresh water. These heat exchangers are located over the discharge tunnel near the circulating water pumps outside the station so that there are no

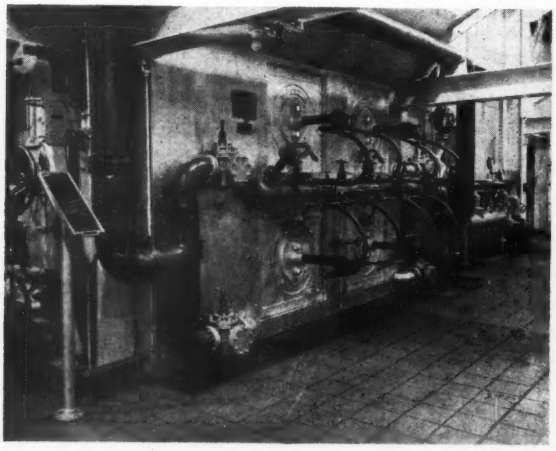


Fig. 4. View of boiler front showing 4 combination gas and oil burners, feedwater control valve (extreme left), water level mirror, differential fuel oil pumps and regulating valves (extreme right)

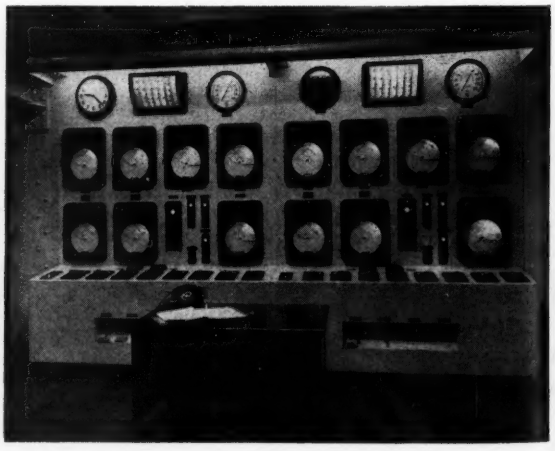


Fig. 5. View of boiler control and instrument panel for Boilers 1 and 2. Note bench board for control sub-panels. This board faces boiler fronts, stands between boilers and turbine

Principal Equipment, Silver Gate Station, San Diego Gas & Electric Co., San Diego, Calif.

TURBO-GENERATOR AND AUXILIARIES

Turbine—1 General Electric Co. 3600 rpm, 35,000 kw, 850 lb gage, 900 F, 21-stage condensing turbine; extraction from 7th, 10th, 14th, and 18th stages for feedwater heating; 43,750 kw at 1½ in. Hg. (abs) back pressure.

Generator and Exciters—1 General Electric Co. 3-phase, 2-pole, 60-cycle, 12,500-v, 50,000-kva, hydrogen-cooled, 0.5 lb gage hydrogen pressure generator; main exciter gear connected, 1772 rpm, 250 v, 185 kw; pilot exciter direct connected to main exciter, 1772 rpm, 250 v, 4 kw.

Oil Purification System—Bowser, Inc., continuous-by-pass oil filtering system; capacity 400 gal per hr.

Condenser—1 Worthington Pump & Machinery Corp. 29,100-sq ft, two-pass, divided-flow, horizontal surface condenser; 4632 1-in. O.D. American Brass Co. seamless drawn aluminum brass tubes, 24 ft effective length; welded-steel condenser shell, cast-iron water boxes, deaerating and reheating hotwell.

Air Ejector—Worthington Pump & Machinery Corp. 3-element, 2-stage, steam jet, air ejector, having combined surface inter- and after-cooler.

Circulating Water Pumps—2 Worthington Pump & Machinery Corp. vertical propeller type pumps; each 15,050 gpm against total head of 26.5 ft of water. Driven by Westinghouse Elec. & Mfg. Co. 125-hp, 2300-v, 600-rpm, squirrel-cage induction motor.

Traveling Water Screens—2 Chain Belt Co. screens, each 17,500 gpm at 8 ft depth of water, distance between sprocket centers 24 ft.

BOILERS AND AUXILIARIES

Boilers—2 Babcock & Wilcox Co., type F, 13,450-sq ft integral-furnace boilers; capacity each 200,000 lb per hr; design pressure 950 psi gage, 900 F; inverted loop type superheater; tubular-type, 18,000-sq ft air heater; Attemperator is outside of boiler setting, maintains superheater outlet temperature of 900 F.

Burners—4 Peabody Engineering Corp. combined gas and wide range mechanical atomizing oil burners, type H-23; Mason-Neilan oil temperature and pressure regulating valves.

Induced Draft Fans—2 Buffalo Forge Co. double-inlet induced draft fans (one for each boiler), capacity 120,000 cfm at 425 F and 12.5 in. water static draft. Each driven by Westinghouse Elect. & Mfg. Co. 2300-v, 3-phase, 1200-rpm, 350-hp motor.

Forced Draft Fans—2 Buffalo Forge Co. fans (one for each boiler), capacity 66,000 cfm at 110 F and 13.0 in. water static draft. Each driven by Westinghouse Electric & Mfg. Co. 2300-v, 3-phase, 1200-rpm, 200-hp motor.

Fuel Oil Pumps—2 Worthington Pump & Machinery Corp. 4-in. rotary fuel oil pumps with helical gears; capacity 180 gpm against 300 lb head at 520 rpm or 90 gpm against 300 lb head at 260 rpm. Each driven by 50-hp, two-speed, two-winding, 3-phase 220-v General Electric squirrel-cage induction motor. Elliott Co. twin strainers on pump suction.

Fuel Oil Differential Pumps—2 United Iron Works constant differential pumps; capacity 35 gpm against 100 lb differential, driven by U. S. Electric Co. 10-hp, 3500-rpm, 220-v motors.

Fuel Oil Heaters—2 Whitlock Mfg. Co. horizontal fuel oil heaters; each 965 sq ft heating surface.

Automatic Controls—Bailey Meter Co. air-operated controls; combustion control; 3-element feedwater control; steam temperature control; feedwater pump bypass control.

FEEDWATER EQUIPMENT

Closed Heaters—3 Alco Products vertical extraction heaters; low pressure, 1265 sq ft (effective); 410—¾-in. O.D. 16 BWG, Admiralty metal tubes; intermediate pressure, 1420 sq ft (effective); 472—¾-in. O.D. 14 BWG, Admiralty metal tubes; high pressure, 1465 sq ft (effective); 488—¾-in. O.D., 12 BWG, Admiralty metal tubes.

Deaerating Heater—1 Cochrane Corp. direct-contact, parallel down-flow, vertical deaerating heater; 500,000 lb per hr; guaranteed to deliver deaerated water containing less than 0.005 cc oxygen per liter at loads below 392,000 lb per hr.

Evaporator—1 Foster Wheeler Corp. 7500-lb per hr, single-effect evaporator; coils 1 in. O.D., 16 BWG, 207 sq ft effective area, arsenical copper.

Chemical Feeder—2 Hills-McCanna Co. positive-displacement variable stroke 1200-lb pumps; capacity 65 gal per hr.

Boiler Feed Pumps—3 Ingersoll-Rand Co. multistage centrifugal pumps; one 600-gpm, 7-stage, 3570 rpm, driven by Westinghouse 2300-v, 600-hp motor; one 1050-gpm, 6-stage, 3570 rpm, driven by Westinghouse 2300-v, 900-hp motor; one 1050-gpm, 6-stage, 3570 rpm, driven by Terry Steam Turbine Co. 950-hp turbine, steam 900 psi, 900 F.

Condensate Pumps—2 Worthington Pump & Machinery Corp. horizontal, three-stage, three-impeller centrifugal pumps, each 682 gpm, 1150 rpm, 284 ft water total head, each driven by Westinghouse Electric & Mfg. Co. 100-hp, 2300-v motor.

Drip Pumps—8 Ingersoll-Rand Co. centrifugal pumps; 3 single-stage horizontal for drains from intermediate heater, evaporator and fuel oil heater; 2 single-stage horizontal for drips from turbine room traps and seal water from main turbine; 1 two-stage horizontal for low pressure heater drain; 2 one-stage vertical for drips from all boiler room traps.

TRANSFORMERS AND SWITCHGEAR

Main Transformers—2 Allis-Chalmers Co. 3-phase, 60-cycle, oil-insulated, self-cooled, 25,000-kva (each) transformers; 12,500-v delta to 66,000-v wye.

Ring Bus Switchgear, Outdoor Type—3 Kelman Electric Co. three-pole, single-throw, 3000-amp, 15-kv circuit breakers; interrupting capacity 1,500,000 kva. Disconnect switches are Delta Star Electric Co., 23-kv, 3-pole, single-throw, group-operated.

Neutral Switchgear and Resistor—General Electric Co. single-pole, single-throw oil circuit breaker, 600 amp, 15 kv. Delta Star Electric Co. single-pole, single-throw, 600-amp, 15-kv disconnect switch. General Electric Co. 3-ohm current-limiting neutral resistor.

Station Auxiliary Transformers—2 Allis-Chalmers Mfg. Co. 3000-kva, 3-phase, 60-cycle, oil-insulated, self-cooled transformers; 12,500-v delta to 2400-v delta.

Auxiliary Power Switchgear—13 Delta Star Electric Co. 2300-v metal clad switchgear cubicles; containing two General Electric 1200-amp, 50,000-kva oil circuit breakers, and 11 General Electric 600-amp, 50,000-kva oil circuit breakers.

240-v Auxiliary Transformers—2 Westinghouse Elec. & Mfg. Co. 3-phase, 750-kva, 2400/240-v transformers, two Westinghouse single-phase, 200-kva, 2400/240-120-v transformers.

MISCELLANEOUS AUXILIARIES

Air Compressors—3 Ingersoll-Rand Co. straight-line, single-stage, double-acting air compressors; one 304 cfm, driven by General Electric 60-hp, 1200-rpm, 220-v, 3-phase, squirrel cage induction motor, for station air; two 76 cfm (each) with graphitic-carbon supporting rings, driven by 20-hp General Electric, 1800-rpm, 220-v, 3-phase, squirrel cage induction motor, for instrument air.

Turbine Room Crane—Harnischfeger Corp., 100-ton, 52-ft span crane, with 10-ton auxiliary.

Outdoor Crane—Harnischfeger Corp., 15-ton, 48-ft-span gantry crane.

Main Ventilation Fans—3 Buffalo Forge Co. double-width, double-inlet fans, capacity 60,000 cfm each at ¾-in. water static pressure and 378 rpm. Each driven by Westinghouse Elec. & Mfg. Co. 20-hp, 220-v, 1800-rpm motor through Texrope drive.

Piping
- Main Steam—Crane carbon moly.
- Boiler Feed Piping—Crane seamless steel grade B.

Valves
- Steam Header Valves—Crane carbon moly 900 lb standard with octagonal ring joints and Stellite seating surfaces.
- Feedwater—Crane steel 1500 lb standard with octagonal ring joints.
- Feedwater Control Valve—Bailey balanced type.
- Blowoff—Edward.
- Non-Return—Edward Intex.
- Safety—Crosby nozzle type.
- Gas Regulating Valves—Main regulators Mason-Neilan; boiler control, Bailey.

Boiler Accessories
- Water Columns—Diamond Power Specialty Corp. bi-color water gauge.
- Soot Blowers—Diamond Power Specialty Corp., two IH and five G9B per boiler. None in air heaters.

salt water lines inside the station, except the rather short main condenser circulating water lines.

Silver Gate is operated as a base load plant. There is no switchboard operator at the plant. The engineer operates the limited amount of electrical equipment that must be controlled by generating station personnel. All other equipment including the adjacent 12-kv and 4-kv substations is operated by the system load dispatcher through supervisory control. An extensive annunciator system, both audible and visual, covers practically every operation in the plant.

All engineering design for Silver Gate Station was done by the Public Utility Engineering & Service Corp. of Chicago. The station was built by San Diego Gas & Electric Co.'s Construction Department which is headed by George F. Phythian, general superintendent of construction. Generating Stations are in charge of H. A. Noble, superintendent of electric production, with W. A. Zitlau in direct charge of the Silver Gate Station.

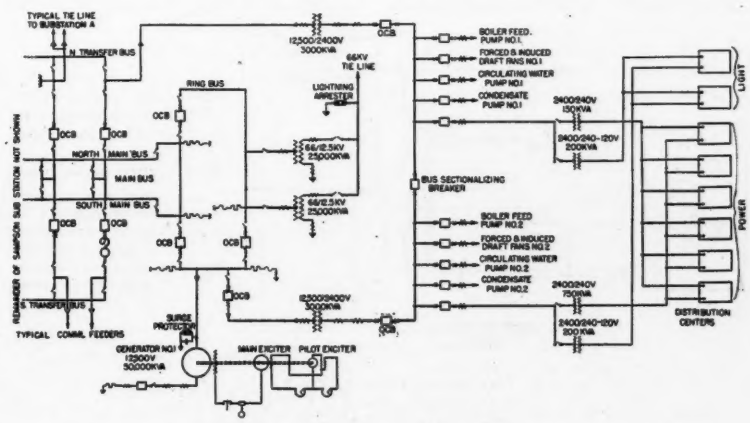


Fig. 6. Single-line electrical diagram of connections for 35,000-kw unit and auxiliaries

Centrifugal Pump Control

Part I

This article, first part of a four-part discussion, takes up concepts of the characteristics of centrifugal pumps . . . This is desirable, in order to make clear how centrifugal pumps operate and just what must be controlled . . . Relations between pump performance characteristics, system characteristics, operating conditions of head and capacity . . . Subsequent articles will deal with fundamental operations the pump controls must carry out, types of controls most commonly used, technique of control application

By Igor J. Karassik — *Application Engineer, Worthington Pump & Machinery Corp.*

IT CANNOT BE DISPUTED that the centrifugal pump has become an indispensable unit of equipment in practically every industrial process of our mechanized civilization. Both the designer of industrial processes and the operating personnel have become increasingly familiar with structural and application problems in the centrifugal pump field. This familiarity was achieved partly through their own studies and observations and partly through the efforts of centrifugal pump engineers, who have constantly worked to remove the veil of mystery which had surrounded the centrifugal pump in its infancy.

This should not be construed to mean that centrifugal pump application problems no longer exist or that every industrial engineer is fully conversant with the most desirable solution of all such problems. The educational task in this, as in any other field, can never be considered as completed, if for no other reason than that new processes are constantly being developed, requiring new applications and creating new problems, which the centrifugal pump engineer must solve before he can disseminate the solution among other interested engineers.

One such group of problems which, today, requires more thorough understanding is that dealing with centrifugal pump controls; that is, with control functions and with the means employed to fulfill these functions. This series of articles is intended, therefore, to present a survey of the fundamental control functions encountered in the application of centrifugal pumps, of the type of controls most commonly used and of the technique of control application.

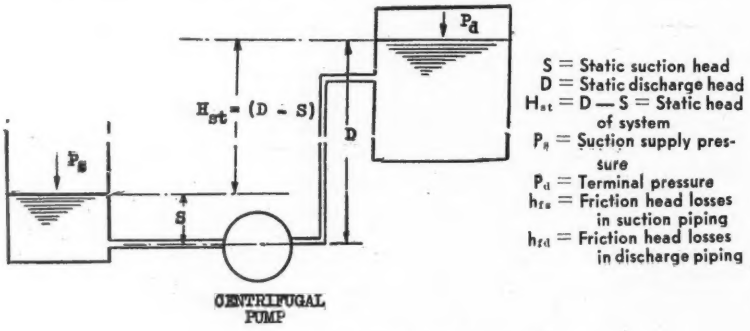
The centrifugal pump is one of the simplest types to control, as compared to reciprocating or rotary pumps. It owes this ease of control to the flexibility of its characteristics and to its adaptability to the varying exigencies of the systems in which it can be applied. But in order to understand the fundamentals of centrifugal pump control, it is necessary to have a clear conception of the relationship between the pump performance characteristics, the characteristics of the system in which the pump operates and the operating conditions of head and capacity. The first article of this series will deal, therefore, with the concepts of centrifugal pump performance.

Pump and System Characteristics

A centrifugal pump installation consists of a system in which the pump is to operate and of the pump itself. The characteristics of the system represent varying conditions of flow and resulting heads while those of the pump represent the available performance which can be utilized to produce flow in the system. Thus it is necessary to differentiate between these two portions of the installation and to analyze system and pump characteristics separately.

A typical pump installation is presented schematically in Fig. 1. In any such a system, the total operating head is made up of the algebraic sum of the static head from supply to discharge level, of the difference between the terminal and the suction supply pressure and of all friction head losses measured at the given capacity. For relatively complex systems, it may become necessary to determine the suction head and the discharge head separately (a suction lift is merely a negative suction head).

The total suction head is the static suction head using the pump centerline as a datum line, minus the friction head losses in the suction piping at the


P_d
$H_{st} = (D - S)$
D
P_s
S
CENTRIFUGAL PUMP
S = Static suction head
D = Static discharge head
$H_{st} = D - S$ = Static head of system
P_s = Suction supply pressure
P_d = Terminal pressure
h_{fs} = Friction head losses in suction piping
h_{fd} = Friction head losses in discharge piping

Total Suction Head $= h_s = S - h_{fs} + P_s$
Total Discharge Head $= h_d = D + h_{fd} + P_d$
Total Operating Head $= H = h_d - h_s$
$= H_{st} + (h_{fd} + h_{fs}) + (P_d - P_s)$

Fig. 1. Determination of operating head of a centrifugal pump system

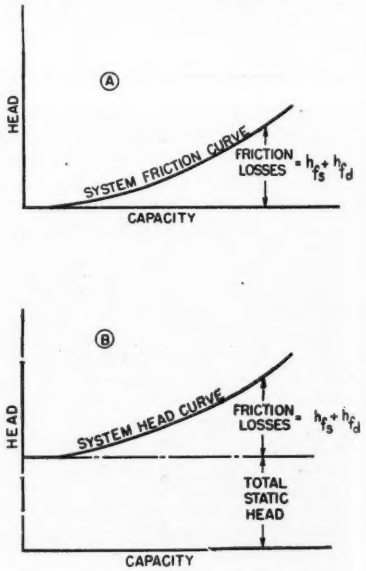


Fig. 2. Two important pump relations. A—System friction curve; B—System head curve

flow capacity being considered, plus any pressure existing at the suction supply. The total discharge head, in a similar manner, is the discharge static head based on the same datum line, plus the friction losses in the discharge piping at the given capacity, plus any terminal pressure existing at the final discharge. The total operating head, then, becomes the difference between the total discharge head and the total suction head. (Of course, all these heads must be expressed in feet of the liquid being pumped).

System Friction and System Head Curves

It is also frequently advantageous to separate frictional losses from the static level and pressure differences, because the former varies with capacity while the latter do not. The friction head loss in a system of pipes, fittings, valves and process equipment (if such is included in the pumping system) varies roughly as the square of the capacity flow through the system. The curve which represents graphically the relation between capacity and friction head losses through the system is called the system friction curve. See Fig. 2-A. When a combination of the friction head losses and of the static heads is plotted against capacity, the resulting curve, Fig. 2-B, is called the system head curve. This curve, in other words, represents the total operating head required at any given capacity for the system, and as will be seen, figures very importantly in the operation of centrifugal pumps, since a pump will always operate at those conditions of head and capacity which correspond to the intersection between its head-capacity characteristic at its operating speed and the system head curve.

What Is Meant by Pump Characteristics?

What, then, is meant by pump characteristics? There are three prime and interdependent pump characteristics: the pump operating speed, the head and the capacity. By established practice, the capacities are plotted as the abcissae and the heads as ordinates at a given constant pump speed. These heads and capacities, of course, are dependent upon a separate set of pump data, such as various linear dimensions of the pump, areas and angles.

It must be remembered that the pump efficiency is not a prime pump characteristic but rather an abstract concept, representative of the ratio between the useful work performed by the pump and the work consumed by the pump in performing its function. For this reason, considerations of efficiency cannot be considered as a fundamental characteristic of a centrifugal pump. More than that, since pump control is seldom directed at the power consumption of the pump, this power consumption must be likewise denied the attributes of a fundamental characteristic. Thus, the only true fundamental performance characteristics are the pump speed, capacity and head.

The application of external factors to modify any one of the fundamental performance characteristics of a centrifugal pump inevitably reacts in modifying the remaining characteristics. For instance, a change in the "external" head against which a pump must operate will, at the same time, alter the pump capacity if the pump is operated at constant speed. If, on the other hand, a pump is operating in a given external system—that is, with a fixed static head and delivering through a given piping system—both the developed head and the delivered capacity will be altered if the speed is changed.

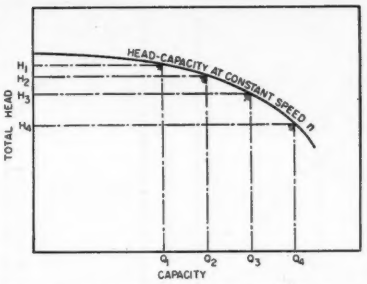


Fig. 3. Operation of a centrifugal pump at constant speed

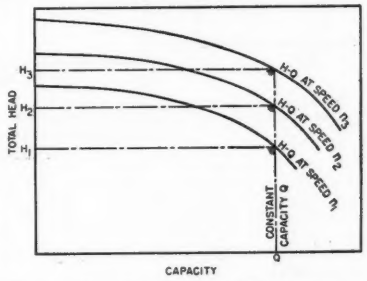


Fig. 5. Operation of a centrifugal pump at variable speed delivering a constant capacity against a varying head

Relations Between the Three Fundamental Characteristics

This illustrates the triangular relation which exists between the three fundamental characteristics of a centrifugal pump. It is possible to vary any combination of two of these characteristics, the third factor remaining constant, as shown in the appended curves. Figure 3 shows the operation of a centrifugal pump at constant speed, the performance curve of this pump indicating that for every given capacity delivered by the pump there is a definite head against which the

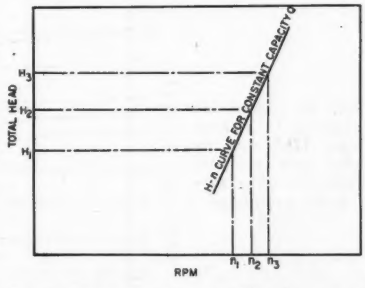


Fig. 7. Operation of a centrifugal pump at variable speed delivering a constant capacity against a varying head, with head plotted against rpm instead of capacity. Compare with Fig. 5

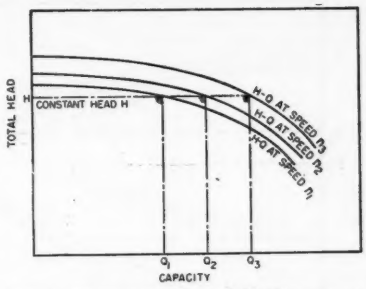


Fig. 4. Operation of a centrifugal pump at variable speed delivering varying capacities against a constant head

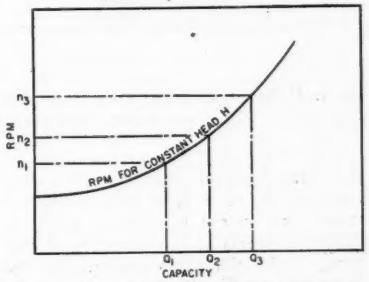


Fig. 6. Operation of a centrifugal pump at variable speed delivering varying capacities against constant head, with capacity plotted against rpm instead of head. Compare with Fig. 4

pump will deliver. Figure 4 shows the operation of a centrifugal pump at variable speed delivering varying capacities against a constant head. Finally, Fig. 5 shows the operation of a centrifugal pump at variable speed, delivering a constant fixed capacity against a varying head. The performance illustrated in the last two figures may be represented in a somewhat different manner. Figure 6, which corresponds to Fig. 4, shows the pump speed plotted against capacity for a given constant head, while Fig. 7, corresponding to Fig. 5, shows the head plotted against speed for a given constant capacity.

One can also vary all three characteristics simultaneously as illustrated in Fig. 8, which shows the operation of a centrifugal pump at variable speed and delivering a variable capacity against a variable head on a system head curve.

Self-Regulation

Of course, any centrifugal pump is to a certain extent self-regulating as regards delivery. Thus, for instance, if

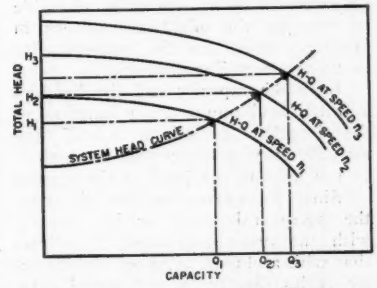


Fig. 8. Operation of a centrifugal pump at variable speed, delivering varying capacity against variable head, showing how all three factors can vary simultaneously

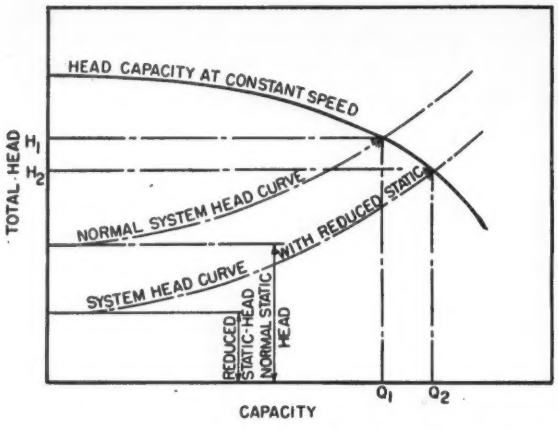


Fig. 9. Curves showing how pump is self-regulating as regards delivery, if static head changes

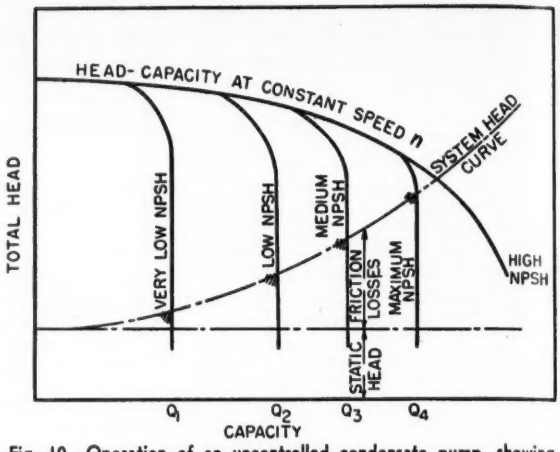


Fig. 10. Operation of an uncontrolled condensate pump, showing self-regulating characteristics. Submergence, representing net positive suction head, NPSH, determines delivery

the static head changes due to variations in tide or in level differences between the source of suction and the delivery reservoir, the capacity of the pump will change automatically as illustrated in Fig. 9. Another example of a self-regulating installation is that of an uncontrolled hotwell or condensate removal pump. In such an installation, the delivery of the pump is controlled strictly by the submergence over the centerline of the pump, this submergence representing the net positive suction head available over and above the vapor pressure. If the inflow to the condenser hotwell is reduced, the centrifugal pump will withdraw more water than is returned to the condenser with a resultant change in the level of the hotwell, a reduction in the net positive suction head available and a consequent reduction in the delivery of the condensate pump. This operation is illustrated in Fig. 10. In this particular case, the operating conditions are stll determined by the intersection of the pump head-capacity characteristic with the system-head curve, but the shape of the former is modified by the prevailing suction conditions without the imposition of any external controls.

Effect of Speed Changes

Since it has been stated that the pump head-capacity curve at the operating speed determines the operating conditions by its intersection with the system head curve, it may be advisable to examine the effect of changes in operating speed on the head-capacity curve of a centrifugal pump.

Both the capacity and the head of a centrifugal pump are a function of the impeller peripheral speed, the capacity varying directly as the peripheral speed and the head as the square.

Since, for a given impeller diameter, the peripheral speed varies directly with the operating speed, it follows that with a change in speed the capacity varies directly as the speed ratio and the head as the square of this ratio. In other words, if subscripts (1) and (2) denote two different speeds:

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2}$$

and

$$\frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2$$

This relationship holds for the entire range of the head-capacity curve so that if the characteristics for one speed are known it becomes very simple to calculate the characteristics for any other speed. Figure 11 illustrates the effect of a change in speed from 1750 to 1500 rpm, for a typical centrifugal pump. The calculations in the accompanying table serve as an example of the method to be followed in determining the new head-capacity curve at a changed speed.

The speed ratio between 1500 and 1750 rpm is 0.857 and all capacities will be reduced in this ratio. The square of this ratio is 0.735 and all heads will be reduced in this ratio.

While, as it has been previously stated, the power consumption of a centrifugal pump does not enter too importantly into the analysis of controls, it may be stated that since the fluid horsepower is proportional to the product of head and capacity and since the efficiency changes relatively little over small speed changes, the power consumption varies as the cube of the speed ratio.

Naturally, these relationships hold only over certain limited speed variations, as when speeds are increased excessively, the effect of the suction conditions on the shape of the head-capacity curve may interfere with a

(*Continued on page* 81)

Table showing method of calculating new head-capacity curve at changed speed.

AT 1750 RPM			AT 1500 RPM
GPM	H IN FT	GPM	H IN FT
0	89.5	$0 \times 0.857 = 0$	$89.5 \times 0.735 = 65.8$
400	87	$400 \times 0.857 = 343$	$87 \times 0.735 = 63.9$
600	84	$600 \times 0.857 = 514$	$84 \times 0.735 = 61.7$
800	79	$800 \times 0.857 = 686$	$79 \times 0.735 = 58.1$
1000	71	$1000 \times 0.857 = 857$	$71 \times 0.735 = 52.2$
1200	57	$1200 \times 0.857 = 1028$	$57 \times 0.735 = 41.9$

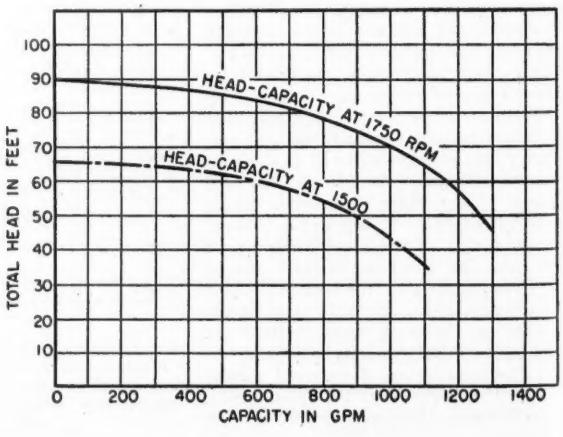


Fig. 11. Effect of change in speed from 1750 rpm to 1500 rpm on performance of a particular centrifugal pump

Water Power Operated
AIR COMPRESSORS

By Paul C. Ziemke

MAN, since the earliest times, has utilized the power of falling waters to perform useful work. We are all familiar with the over and under shot waterwheels of the early pioneers who used that slow but reliable method to grind grain or to furnish the primary power for the early factories of their time. Hydroelectric plants have become so commonplace that unless the project is of the most modern and gigantic proportions but little public attention is aroused. However, the direct use of water power for the purpose of compressing air is still very much of a novelty since there are only two such installations in America.

The finding of copper ores in the virgin forest of northern Michigan led to the development of the Victoria Mine and the Village of Rockland. The nearby presence of a waterfall led the engineers of the project to investigate the possibilities of developing the site for an air compressing plant. In 1906 construction was begun on a large plant known as the Taylor compressor. The design called for three units with a total capacity 34,000 to 36,000 cu ft of free air per min. The plant operated successfully for quite a number of years during the years when copper ores in paying quantities were available in the Victoria and adjacent mines.

The originality of the plant excited the interest of Professor F. W. Sperr of the Michigan College of Mines & Technology at Houghton, Mich.

Under Professor Sperr's direction a series of exhaustive tests were made on a single intake head of the plant, the results of which are indicated herewith.

Table Showing Results of Test on Victoria Company

Air Measurements				Water Measurement			
Free Air cfm	Absolute Prs psi		hp	cfm	Head ft	hp	Eff Per cent
	Free Air	Comp Air					
10,580	14	128	1430	13,057	70.5	1741	82.17
11,930	14	128	1623	14,820	70.0	1961	82.27
9,238	14	128	1248	12,710	70.6	1700	73.50

In the diagram, Fig. 1, air tubes are represented at C, all terminating at the conical entrance B, to the down flow pipe E. The water supply is furnished through the flume D. As the water falls it draws air through the small tubes, carrying it down to the separating tanks G, where it is liberated at pressures depending on the weight of the water in the vertical pipe H. The compressed air is then conducted through the pipe K to the place where it is stored in receivers for use in or about the mine. The vertical distance from M to the tail race L represents the fall of the water that is available. The oxygen content of the air is reduced, which renders the air less beneficial for the purpose of mine ventilation in case the exhaust from machinery or tools is depended on to augment the existing ventilation. The Taylor system offers a unique and effective solution for harnessing water power in those locations where the need for large quantities of compressed air is present. It has the advantage of extreme simplicity with a minimum of maintenance or operating expense, and excellent efficiencies are assured. As in the case of hydroelectric plant construction the first cost is high.

The second water power operated air compressing plant is located in the busy mining field at Cobalt, Ontario. This installation, shown in Fig. 2, was designed for 40,000 cu ft of free air per min to be compressed to a gage pressure of 120 psi. The compressed air is used by mines now operating at full capacity in producing minerals for the war effort. A main line pipe measuring 20 in. in diam conducts the air a distance of 9 miles to a junction with two 12-in. pipe lines that distribute air for a total distance of 21 miles. The construction of this compressor varies somewhat compared to that of the plant at the Victoria Mine. The water is admitted through suitable gates to the two "heads" each 16 ft in diam and containing 66

(*Continued on page* 81)

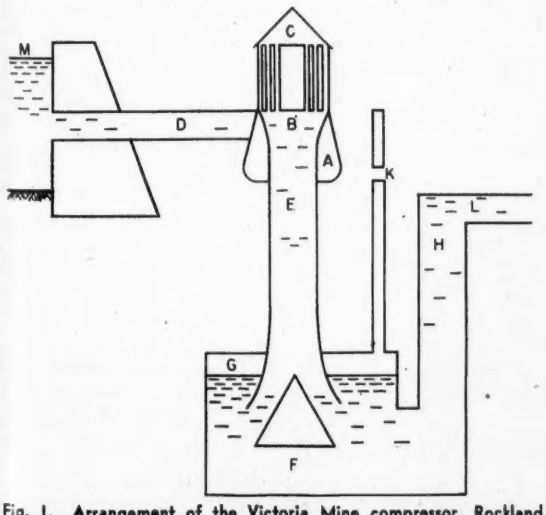


Fig. 1. Arrangement of the Victoria Mine compressor, Rockland, Mich.

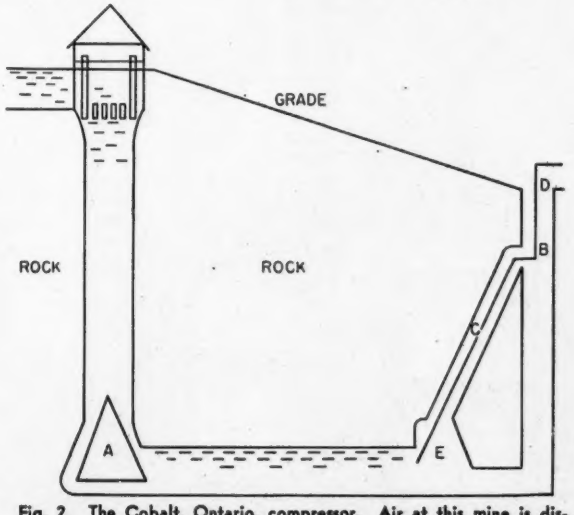


Fig. 2. The Cobalt, Ontario, compressor. Air at this mine is distributed a total distance of 21 miles

Steam For Super-octane

By G. C. LESLIE
Utilities Foreman
Richfield Oil Corporation

THE RICHFIELD OIL CORP. has recently placed in operation at Watson, Calif., near Los Angeles, one of the most modern oil refineries in the world for the quantity production of high-octane aviation gasoline.

Since large quantities of relatively high pressure steam are used in the refinery operations, a new high pressure steam plant was constructed as part of the new project.

As a preliminary to the design of the new steam plant, a study was made to determine the most economical steam pressure and temperature. Existing boiler plant steam pressure is 150 psi. The new refining processes at Richfield included reboilers and heaters that would either require steam at a pressure considerably over 150 psi, or the construction of a heat exchanger. It was decided to use 600 psi steam, reducing to 450 psi for the high temperature reboilers and 150 lb for all other uses by being used in 600 psi turbines, exhausting into the 150 lb system and any excess of 600 lb steam being bled through pressure reducing stations into the 150 lb system.

Two Combustion Engineering Corp. Type VU boilers were installed, to produce steam at 600 psi and 750 F total temperature. Each boiler is equipped with two sets of air and flue gas equipment, i.e. two Ljungstrom air preheaters, two forced and two induced draft fans.

The boilers are equipped with Peabody combination gas and fuel oil burners, and for the present will operate on a block load while the old boiler plant will take the swings. The boilers are semi-enclosed and only the boiler fronts and the pumps are housed. The boilers themselves, together with the pressure reducing stations, fans and desuperheaters, are outside. There is a pressure reducing station for each boiler, each of which is large enough to take the total load. Both the pressure reducing stations and the desuperheaters are automatically controlled by Bailey instruments.

The plant was designed and built by The Lummus Co., and includes two innovations that will be appreciated by the operators. First, the steam piping is so arranged that all valves and regulators can be reached from the floor without the use of platforms or ladders. Second, all the pumps, with the exception of the boiler fuel oil pumps, are located in a straight line in the pump house, which extends across the front of the boilers. All boiler auxiliaries are driven by steam turbines. The boiler feed pump turbines are driven by 600 lb steam and exhaust into the 150 lb system. The other pump turbines using 150 lb steam exhaust into the 25 lb system.

The forced and induced fan turbines operate on 600 lb steam and they exhaust into the 150 lb header, while the preheater turbines operate on 150 lb

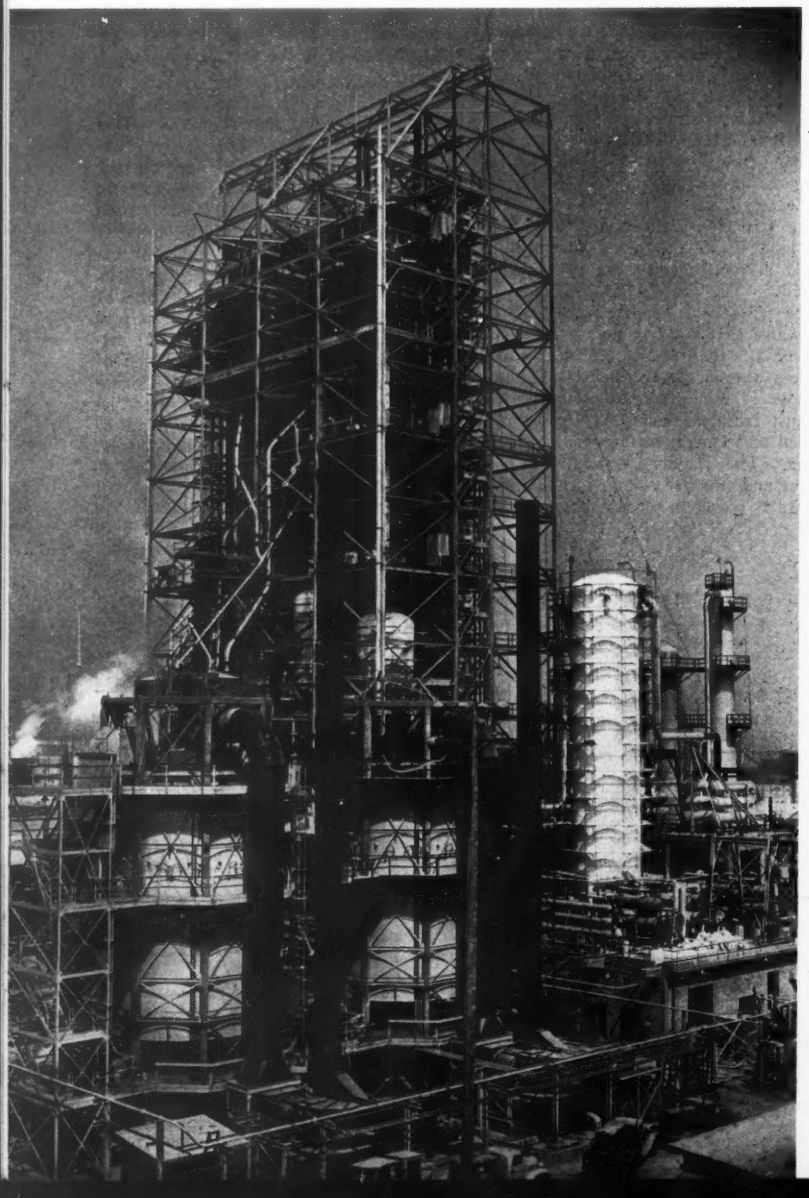


Fig. 1. This is the "Cat Cracker," one of many units in the recently completed Richfield Refinery near Los Angeles. Twenty stories high, this structure is the heart of the new process because it changes low-grade fuel vapor into high-grade aviation base stock. "Cat Cracking" makes quantity production of super Octane Aviation gasoline possible. Its huge catalyst chambers contain 750 tons of glass-like particles known as bead catalyst

Gas

Fig. 2. (Right) Soaring skyward and suggesting "crow's nest" platforms on a battleship are these towers in the Alkylation unit. It is here that Iso-Pentane and Iso-Butane are combined into Alkylate, the blending agent that puts long range into super-octane aviation gasoline

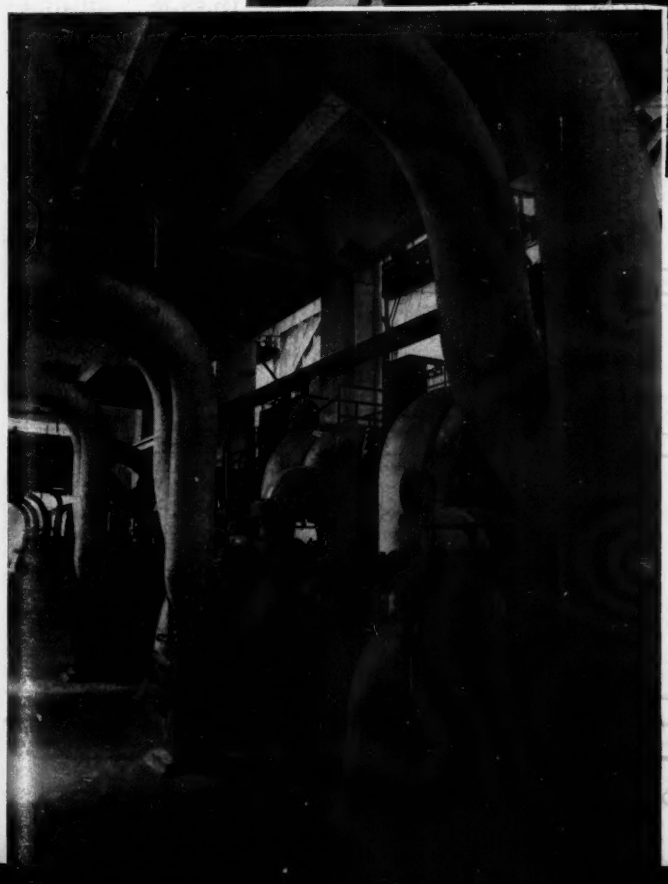


Fig. 3. (Left) A group of steam pumps in the new Richfield refinery

steam and exhaust into the 15 lb steam main leading to the softeners. All turbines are equipped with individual safety releases so that the turbines will be protected should the pressure in the 150 lb system become dangerously high.

In addition to the boiler house auxiliaries, 600 lb steam is used on 3200 hp of turbine drives on cooling tower circulating pumps, blowers, etc. These turbines exhaust into the 150 lb refinery system. A large part of the exhaust steam is used for heating and processing, and is maintained at different pressures in different areas depending upon the temperature requirements of the individual processes. Accordingly, there is a 40 lb, a 30 lb and a 25 lb exhaust

(*Continued on page* 83)

Construction Costs at Woodcock

Detailed break-down of costs, including all charges, for the construction of three present units, total capacity 17,500 kw, at Woodcock Electric Generating Station, Bluffton, Ohio. The 5000-kw Unit No. 1 was installed in 1938; a second 5000-kw unit, No. 2, in 1939; the final 7500-kw unit in 1942. Tables show costs of each item of land and structures, boiler and turbine plants, electrical system. Total cost of three units $99.40 per kw (at 0.8 pf), or $79.50 per kw (at 100 per cent pf) of installed capacity

SHORTLY AFTER the first 5000-kw generating unit was placed in operation in 1938 at the Woodcock Electric Generating Station of Central Ohio Light & Power Co. at Bluffton, Ohio, a complete description of the station was published in POWER PLANT ENGINEERING, October, 1938, pages 618 to 624 in an article entitled "Economy With Medium Pressure, High Temperature." The station was originally built to contain the first two 5000-kw units; the unit design — one boiler per turbine — was followed and two boilers and one of the 5000-kw turbine-generator units were installed in 1938, going into operation on April 1. The second 5000-kw unit was installed and placed in operation the early part of 1939.

To meet the expanding load due to war conditions the third and last turbine-generator and its boiler, designed for a capacity of 7500-kw, were installed in 1941 and placed in operation in the early part of 1942.

For this interesting station, which was designed for high economy employing moderate pressure and high temperature, the total cost of construction for the three units was $1,738,898.78.

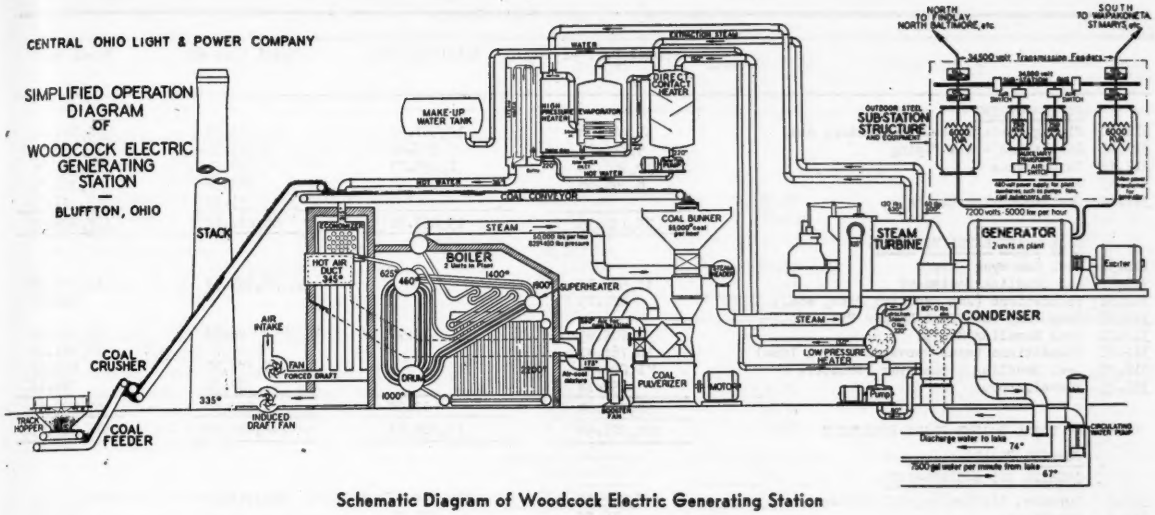
Broken down, as shown in Table I to IV, this is as follows:

Unit No. 1 Total cost including engineering.....	$ 910,380.48
Unit No. 2 Total cost including engineering	202,591.79
Unit No. 3 Total cost including engineering	625,926.51
Total	$1,738,898.78

This gives a cost per installed kilowatt (generator name plate rating) of capacity of $99.40. The generator ratings are designed for 0.8 pf, the total rating being 21,875 kva. This gives a cost of

Table I. Construction Costs, Woodcock Electric Generating Station, including land, structures and site improvements and main building excavation, foundations, superstructure and steel work

		Total Unit #1	Total Unit #2	Total Unit #3	Total WEGS
	BOILER PLANT & EQUIPMENT				
	BOILERS AND ACCESSORIES				
312.1	Boilers	117,855.44		103,579.70	221,435.14
312.2	Boilers & Automatic Combustion Cost	10,512.88	205.22	4,582.37	15,300.47
312.2A	Panels & Other Boiler Control Meters			8,622.99	8,622.99
312.3	Foundations	5,038.07		332.72	5,370.79
312.4	Concrete Chimney	6,010.54		119.27	6,129.81
312.5	Miscellaneous	431.34		1,087.17	1,518.51
		139,848.27	205.22	118,324.22	258,377.71
	DRAFT SYSTEM				
312.10	Forced & Induced Draft Fans	8,705.12		7,255.25	15,960.37
312.11	Smoke Flues	5,184.09		2,561.82	7,745.91
312.12	Ducts	108.53		1,343.65	1,452.18
312.13	Insulation of Flues & Ducts	580.27	.79		581.06
312.14	Foundations and Miscellaneous	792.20	20.09	581.63	1,393.92
		15,370.21	20.88	11,742.35	27,133.44
	FUEL SYSTEM				
312.20	Mills, Exhausters & Motors	39,807.36	25.99	18,592.63	58,425.98
312.21	Coal Scales	4,693.87		2,084.01	6,777.88
312.22	Coal Valves and Spouts	843.48		696.49	1,539.97
312.23	Foundations & Miscellaneous	869.09		842.54	1,711.63
312.24	Boiler Control Installation	1,771.17			1,771.17
		47,984.97	25.99	22,215.67	70,226.63
	FEED WATER SYSTEM				
312.30	Boiler Feed Pump	8,072.96	3,059.64	5,031.12	16,163.72
312.31	Service Pumps	843.24		338.26	1,181.50
312.32	Drain Pumps			309.43	309.43
312.33	Deaerating Heaters	6,047.39		6,767.56	12,814.95
312.34	Closed Heaters	4,029.20	1,032.33	4,557.54	9,619.07
312.35	Evaporator Plant	2,600.30		2,475.67	5,075.97
312.36	Water Treatment				
312.37	Tanks	1,902.72		913.03	2,815.75
312.38	Water Line				
312.39	Miscellaneous	2,933.26		269.60	3,202.86
312.39A	Regulators (Boiler Feed Water)			643.27	643.27
		26,429.07	4,091.97	21,305.48	51,826.52



Schematic Diagram of Woodcock Electric Generating Station

Units No. 1 and No. 2, 5000-kw each; Unit No. 3, 7500-kw; total capacity 17,500-kw at 0.8 pf. The following tables show Power Plant Construction Costs only, including all charges. No interconnecting transmission lines or sub-stations are included

Table II. Construction Costs, Woodcock Electric Generating Station, for boiler plant equipment, including boilers and accessories, draft and fuel systems and feedwater system

		Total Unit #1	Total Unit #2	Total Unit #3	Total WEGS
	LAND				
310.2	Cost of Acquisition	12,543.22			
310.6	Conveyance & Notary Fees				
310.7	Fees, Commissions & Salaries	335.74			
310.8	Clearing Site	93.66			
310.12	Surveys in Connection with Acq.	145.84			
310.14	Title Examination	4,417.65			
310.15	Water Supply, Pumping Sewage, etc.	2,268.76			
	Total Land	19,804.87			19,804.87
	STRUCTURES SITE IMPROVEMENTS				
311.11	Clearing Land	177.02			177.02
311.12	Track-Exclusive of Substa.	8,047.06	63.41		8,110.47
311.13	Fence - Property	1,388.52			1,388.52
311.14	Roads & Sidewalks	6.35			6.35
311.15	Drainage	440.24			440.24
311.18	Miscellaneous	975.06	14.75		989.81
311.19	Grading & Landscaping	653.89			653.89
		11,688.14	78.16		11,766.30
	MAIN BUILDING STRUCTURES				
311.21	Building Foundations	12,019.34		15,275.64	27,294.98
311.24	Excavation	1,672.63		1,420.35	3,092.98
		13,691.97		16,695.99	30,387.96
	MAIN BLDG. SUPERSTRUCTURE & STEEL WORK				
311.30	Masonry & Brickwork	53,206.86		8,846.30	62,053.16
311.31	Roof & Roof Covering	6,684.89		5,206.47	11,891.36
311.32	Miscellaneous	1,453.79			1,453.79
311.34	Heating, Piping, Radiation			127.30	127.30
311.37	Drinking Water	1,082.37			1,082.37
311.38	Interior Construction	6.10		397.32	403.42
311.39	Lighting - Inside Wiring, etc.	5,978.48	65.33	3,023.27	9,067.08
311.39A	Lighting Fixtures - Inside	770.67	308.62	299.06	1,378.35
311.39B	Inside Telephone Work	1,019.26			1,019.26
311.40	Structural Steel	15,746.88		15,186.95	30,933.83
311.41	Coal Bunkers	8,780.87		6,601.27	15,382.14
311.42	Miscellaneous Steel & Iron	13,815.82	1,596.02	7,179.83	22,591.67
		108,545.99	1,969.97	46,867.77	157,383.73
	Total Structures & Improvements	133,926.10	2,048.13	63,563.76	199,537.99

Table III. Construction Costs, Woodcock Electric Generating Station, including piping system, coal and ash handling equipment, and turbine plant equipment

		Total Unit #1	Total Unit #2	Total Unit #3	Total WEGS
	PIPING SYSTEM				
312.40	Piping, Main Steam, Feed Water, etc.	51,460.08	10,587.54	61,015.57	123,063.19
312.41	Insulation - All Piping	5,020.23	795.06	5,575.35	11,390.64
312.42	Instruments	10,267.36	2,058.77	1,198.58	13,524.71
312.43	Valves	8,390.66	212.54	783.52	9,386.72
312.44	Heating System Piping			43.79	43.79
		75,138.33	13,653.91	68,616.81	157,409.05
	COAL & ASH HANDLING EQUIP.				
312.50	Coal Conveyor				
312.51	Ash Handling Equipment	11,570.39		2,347.19	13,917.58
312.52	Foundations (Ash Handling Pits, etc.)	829.25			829.25
312.53	Sump Pump for Track Hopper Pit				
312.70	Coal Handling Equip.	33,205.95	10.90	96.80	33,313.65
312.71	Foundations (coal conveyor & drag line)	10,761.41			10,761.41
312.72	Coal Handling & Conveyor Structure	1,204.51		1,724.12	2,928.63
312.73	Miscellaneous	159.18		87.56	246.74
		57,730.69	10.90	4,255.67	61,997.26
	TOTAL BOILER PLANT EQUIPMENT	362,501.54	18,008.87	246,460.20	626,970.61
	TURBINE PLANT				
	TURBINE AND ACCESSORIES				
314.1	Turbine, Air Cooler, Oil Cooler	148,022.02	122,394.35	203,517.91	473,934.28
314.2	Air Ducts	18.55	170.21	28.37	217.13
314.3	Foundations, including labor,	3,482.11	2,433.12	4,059.84	9,975.07
314.4	Oiling System, Piping, Filter, etc.	1,221.36	359.97	1,131.84	2,713.17
314.6	Miscellaneous	11.36	110.58	1,686.93	1,808.87
		152,755.40	125,468.23	210,424.89	488,648.52
	CONDENSING EQUIPMENT				
314.10	Condenser, Condensate Pumps, Motors, etc.	24,910.46	22,160.47	28,010.90	75,081.83
314.11	Circulating Water Piping & Valves	5,654.16	1,878.62	5,415.49	12,948.27
314.12	Foundations	226.72	87.84	554.54	869.10
314.13A	Main Circulating Water Pumps	7,560.48		5,559.42	13,119.90
314.14	Condenser Equip. - Misce).	91.26	203.61	147.25	442.12
		38,443.08	24,330.54	39,687.60	102,461.22
	CIRCULATING WATER SYSTEM				
314.20	Intake Flue & Tunnel	30,500.75			30,500.75
314.21	Discharge Well	21.85			21.85
314.22	Screens	368.25			368.25
314.23	Circulation Water Pipes	122.71		64.73	187.44
314.24	Pump Rental (Construction)	1,260.06			1,260.06
314.25	Pump Installation (Construction)	3,144.98			3,144.98
314.26	Pump Operation (Incl. Power)	1,219.76			1,219.76
		36,638.36		64.73	36,703.09
	Total Turbo Generator Unit	227,836.84	149,798.77	250,177.22	627,812.83

$79.50 per kva and since the company's system operates at substantially 100 per cent power factor the unit cost becomes about $80.00 per kw of effective capacity as sufficient boiler capacity is installed for 21,875 kw effective capacity.

The accompanying construction cost tables are self-explanatory, in connection with the following brief review of the general design of the station.

The Central Ohio Light & Power Co., with general offices at Findlay, Ohio, operates in two areas in Ohio, known as the Eastern and Western Divisions. Power requirements for the Western Division, in which Findlay is located, are served almost entirely by the new Woodcock Station through about 425 miles of transmission and distribution lines located in portions of Wood, Allen, Van Wert, Hancock, Auglaize, and Shelby Counties. Electric service in this Division is retailed to 16 communities and wholesaled to 7 municipalities, to 2 REA Cooperatives and the Marion-Reserve Power Company, the latter through a connection at St. Marys, Ohio, where the company maintains a reserve steam generating plant of 4000 kw installed capacity. The total customers served in the Western Division are in excess of 10,000 customers, and the total customers served in both the Eastern and Western Divisions total nearly 17,900 customers.

The company also operates a steam generating plant at Findlay, Ohio, for peak load and reserve capacity and also during the heating season in connection with a central hot water heating system located in Findlay. This plant has an effective capacity of 6500 kw.

In designing the Woodcock Station, studies of the factors involved showed that the new station should have two 5000-kw units initially and that the most economical operating conditions would be with steam at 450 psi 825 F. These conditions would take advantage of the most modern high temperature practices to give a low heat rate, yet avoid high costs of extensive use of special steels. The cycle selected, with three stages of extraction feedwater heating, had a design heat rate at full load and 1.5 in. Hg of 15,050 Btu per net kwhr sent out. The design heat rate for the third unit of 7500 kw was 14,150 Btu at 1.5 in. Hg.

The accompanying station diagram shows schematically the cycle of the plant and approximates the general physical layout. It shows the connections of one of the two initial 5000-kw units. The cycle and physical arrangement of equipment for Unit No. 3, the 7500-kw unit, is essentially the same. Complete details, cross-sections and heat balance diagram for the original station, together with a detailed list of equipment, were given in the POWER PLANT ENGINEERING article cited above.

In the initial installation, the turbine-generator unit consisted of a 5000-kw 3600 rpm single-shaft turbine driving a 5000-kw, 0.8 pf 7200-v, 3-phase 60 cycle generator. The turbine exhausts to a 4500-sq ft two-pass condenser, supplied with circulating water by two vertical circulating pumps. The main turbine is bled for feedwater heating as shown on the diagram. Generator leads are permanently connected on the low side of a 6000-kva, 7200/34,500 v transformer installed in the outdoor switchyard. Auxiliary power is taken direct from 34,500-v bus, through two auxiliary 750-kva 34,500/480-v transformers.

Table IV. Construction Costs, Woodcock Electric Generating Station, including indoor main primary electrical equipment, indoor and outdoor 480-v auxiliary equipment, outdoor electrical equipment, miscellaneous station equipment and total costs for three units

		Total Unit #1	Total Unit #2	Total Unit #3	Total WEGS
	ELECTRIC EQUIPMENT				
	ELECTRIC PLANT - INDOOR MAIN PRIMARY				
315.1	Main Switchboard - Generator & Feeder Panel	22,627.07	7,872.66	8,142.43	38,642.16
315.2	Switchboard Control Cable & Conduit-In & Out	7,798.58	2,345.13	5,048.54	15,192.65
315.3	M. G. Exciter	3,191.48		6.44	3,197.92
315.4	Storage Battery	2,021.38			2,021.38
315.5	Miscel. & Inside Grounding	2,162.87	177.02	2,876.10	5,215.99
315.6	Master Clock (G. E. Contract)		3.64		3.64
		37,801.78	10,398.45	16,073.51	64,273.74
	480 VOLT AUXILIARY EQUIPMENT INDOOR & OUTDOOR				
315.10	Auxiliary Transformer Fans-480 V. Cap.	13,921.13		7,487.50	21,408.63
315.11	600 V. Aux. Switch Group & Control	10,816.73	136.26	8,504.56	19,457.55
315.12	Miscellaneous Installations	2,648.64	68.35	2,434.92	5,151.91
315.13	Other 600 V Aux. Cable, etc.	9,698.07	86.06	3,271.41	13,055.54
315.14	Main Auxiliary	4,287.99			4,287.99
		41,372.56	290.67	21,698.39	63,361.62
	Total Accessory Elec. Equipment	79,174.34	10,689.12	37,771.90	127,635.36
	MISCELLANEOUS POWER PLANT EQUIPMENT				
316.1	Station Air Compressor Tools, Bearings, etc.	2,650.56			2,650.56
316.2	General Equipment	49.23		63.20	112.43
316.3	Crane Turbine Room	4,935.10		27.48	4,962.58
316.4	Fire Protection Equipment	880.98		800.27	1,681.25
	Total Miscel Power Plant Equip.	8,515.87		890.95	9,406.82
	STATION EQUIPMENT - OUTDOOR				
343.1	Main Power Transformers	18,326.48	13,788.26	18,255.89	50,370.63
343.2	Oil Circuit Breakers	15,689.75	3,987.14	4,122.20	23,799.09
343.3	Current & Potential Instruments	7,501.17	772.15	363.88	8,637.20
343.4	Lightning Arrestors, Grounding, etc.	3,799.62	83.50	134.17	4,017.29
343.5	Main Substation Structure Air Break Switches, Busses, Steel Work, Etc.	19,293.13	2,089.05	1,288.25	22,670.43
343.6	Substation Foundations, Foundation Bolts, Fence Track, etc.	6,418.85		566.63	6,985.48
343.8	Outdoor Panels, DC Control, etc.	198.78	27.78	62.33	288.89
343.9	Main 7.5 Kv Generator Cables, Potheads, Ducts, etc., to Main Generator	2,071.78	1,299.02	1,757.62	5,128.42
343.10	Lighting - Outdoor, Wiring & Fixtures	1,261.79		125.06	1,386.85
343.11	Miscellaneous & Spare Parts	3,109.33		386.45	3,495.83
343.13	Testing & Temp. Operation				
		77,670.73	22,046.90	27,062.48	126,780.11
344	Station Office Equipment	950.19			950.19
	TOTAL	910,330.48	202,591.79	625,926.51	1,738,898.78

In the initial installation, the two boilers, one for each of Units Nos. 1 and 2, were installed at the same time. Each of these was a special 3-drum unit as shown in the diagram, designed to deliver 60,000 lb per hr of 450 psi, 825 F steam at the superheater outlet. Each boiler unit is equipped with a tubular type air preheater, one forced draft and one induced draft fan and is fired by pulverized coal. This is pulverized by two bowl mills per boiler and fed to each furnace by two flare type burners. Three boiler feed pumps (2 motor driven and 1 steam), of 160 gpm capacity each at 1594 ft head were installed to serve the first two units of the station. The boilers are under full automatic combustion control.

The third generating unit, of 7500-kw capacity, is similar in design, arrangement and make of major equipment with the first two. The only differences are those produced by the larger capacity and a few differences in details of auxiliaries.

One of the interesting features of Woodcock Station is the use of an abandoned limestone quarry, filled and supplied by underground springs, for condenser circulating water, and the available data indicate that the cooling pond of 27 acres in area would be adequate for a capacity of about 20,000 kw without spraying. Data subsequently collected on the temperatures and levels of this pond will be presented in a future article.

The presentation of the accompanying cost data typifies the progressive and cooperative spirit of the entire Central Ohio Light & Power Co. organization, every member of which is proud of the company's service, of the Woodcock Electric Generating Station and of his part in its construction and operation. We are particularly indebted to John S. Sawvel, formerly superintendent of operation and now chief electrical engineer for the company, for his most cordial cooperation in supplying these data. The engineering design of the station was by Sargent & Lundy of Chicago.

Steam For Super-Octane Gas (*Continued from page 79*)

system. Should there be a deficiency of 25 lb steam for feedwater heating, there is a pilot-operated reducing valve to feed 150 lb steam into the 25 lb header. Two 12 in. Cochrane multiport relief valves are installed on the 25 lb exhaust line to exhaust to the atmosphere

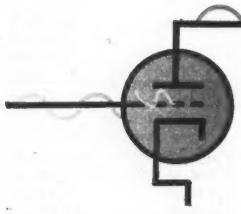
Laboratory

A very complete water testing laboratory is located at one end of the chemical storage and mixing building. This laboratory is equipped to make all tests on raw and treated water, boiler blowdown and condensate. Also, all cooling water control will be directed from this laboratory.

Instrumentation

The pumps are controlled from the instrument board by means of Bailey instruments operating Mason Neilan motor valves. The motor valves are equipped with valve positioners and Powers bellows operate reverse acting trapping valves, which lock all motor valves should an air failure occur.

History and Development of the ELECTRONIC POWER CONVERTER



ABOUT A YEAR AGO, a 20,000-kw electronic power converter was installed by the General Electric Co. at the Edgar Thompson Plant of the Carnegie-Illinois Steel Co. This converter is designed to exchange power, reversibly, between 25 cycle, 44-kv and 60 cycle, 69-kv systems. It was installed as two complete 10,000-kw units. The three-phase double way (full-wave) power circuit includes main transformers, current limiting reactors, rectifier and inverter units, using GL-506 sealed ignitrons and a d-c link. The installation is permitted to operate at 125 per cent load for one hour and at 200 per cent load for one minute.

The installation of this converter was notable in that it was the largest unit of this kind ever installed and it was the subject of three papers presented at the AIEE Summer meeting in St. Louis, this year.

Because of the fact that this is a relatively new type of equipment, it may be of interest to consider the history of the electronic power converter in some detail as outlined by Dr. E. F. W. Alexanderson and E. L. Phillipi, both of General Electric, at the St. Louis meeting.

The term electronic power converter itself needs some definition. The object may be to convert power from direct current to alternating current, or to convert power from one frequency to another, or to serve as a commutator for operating an a-c motor at variable speed, or for transformation of high tension direct current into low tension direct current. It is, thus, not the objective, but the means which characterizes the electronic power converter.

History

Within the scope of the definition a mercury arc rectifier is an electronic power converter. From this standpoint we must trace its history back more than 40 yr. During the first 20 yr of this period the development was rather slow. An important discovery was made in 1913, however, when Dr. Langmuir found that a negative electric potential introduced between the cathode and anode, prevented the start of current flow through the anode.

About this time also the three electrode high vacuum tube was being developed and since these were soon used successfully at high voltage to convert direct current into alternating current of audio and radio frequencies, serious thought was given to their use for power conversion. The high internal voltage drop in these tubes, however, was a serious obstacle and so attention returned to the mercury arc. Thus it was, that 10 yr after Langmuir's discovery, tests were made that proved that the mercury arc rectifier could be inverted so as to convert direct current into alternating current.

The tests were made with a standard high tension rectifier of the type used for series arc lighting. It had a bulbous head and two upturned side arms. Carbon electrodes were introduced at the elbows of the side arms and connected to the control circuit. Direct current power of 9000 v was successfully converted into alternating current and then reconverted into low tension direct current.

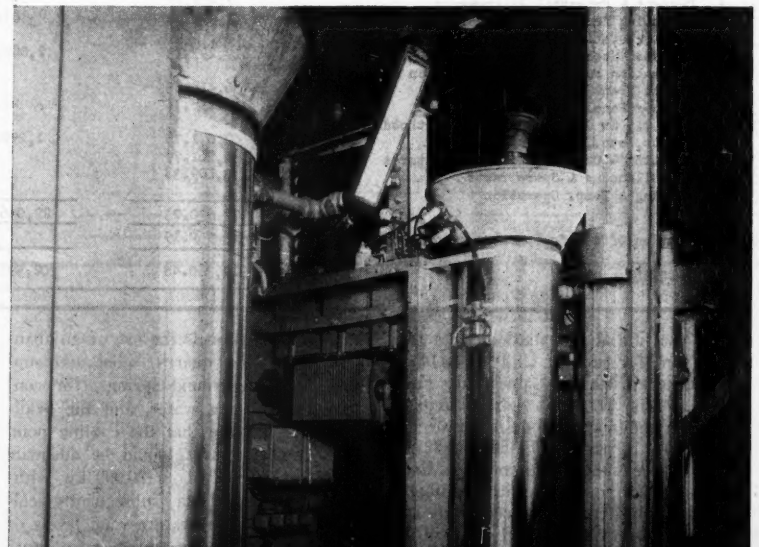


Fig. 1. A close-up of a portion of the 20,000-kw, Electronic Power Converter installation at the Edgar Thompson Plant of Carnegie-Illinois Steel Co. This view shows two of the Type GL-506 Pentode-Ignitron Inverter/Rectifier Tubes with grid control equipment in rear

A new electrical industry was immediately foreseen where power would be transmitted long distances by high voltage direct current and railroads would be electrified by locomotives carrying electronic converters operating from high voltage direct current trolleys, converting to low voltage d-c motors. After another 20 yr, this new industry is well under way, on a modest scale perhaps but comprising installations up to 20,000 kw.

Evolution of the Electronic Converter

The first tests of the inverter were made with a mercury pool tube and the latest installations also have mercury pool cathodes. Between these points there is, however, a significant development. The structure of the tube itself can assume a number of successful forms such as the thyratron, the ignitron, and the excitron, but all of these forms of tubes have certain characteristics in common which force the electrical engineer to accept a new point of view in the methods of its application. This is probably the reason why the practical development has been rather slow. There has been an unwillingness to face the facts or what so far appear to be the facts, that high voltage tubes are subject to momentary faults known as arc backs and loss of grid control. The hope that the tubes could be so improved that these

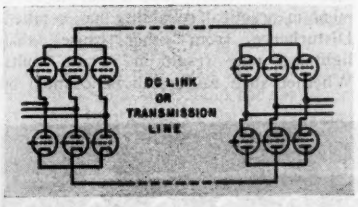


Fig. 2. Electronic Converter, Dual Conversion Type

faults could be eliminated has so far been wishful thinking. Now, a much more constructive point of view has been adopted which accepts the electronic faults as inevitable while measures are taken which render the faults perfectly harmless so long as the incidence of the faults is kept within reason. Installations of d-c power transmission and electronic frequency changers at present are operated on this principle with great success. Electronic faults occur several times a day. They can, however, be observed only by delicate instruments and do not in any way interfere with power service.

Suppression of Electronic Faults

An electronic fault may or may not result in a short circuit, depending upon what means are used to suppress it. In low tension rectifier installations the faults occur so seldom that it has proved satisfactory to disconnect the fault by a high speed circuit breaker. In high tension installations the faults occur so often that this would not be permissible because power delivery must be continuous. In the original installation of d-c power transmission for the New York Power and Light Corp. between Mechanicville and Schenectady,

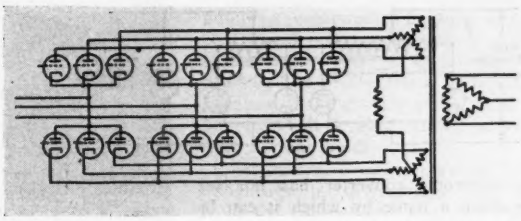


Fig. 3. Single Conversion Type Frequency Changer

this situation was first met by the use of constant current as described in a paper in 1935 by Willis, Bedford and Elder. In a constant current system a momentary short circuit is of no significance. Such a system is therefore adapted to the characteristics of the electronic converter. Operation at constant current was successfully continued for four years but when plans were made for future installations it was found that the constant current system was not well adapted to existing practice of power distribution. The reactance capacity networks used for conversion between constant current and constant potential were therefore removed and the system has been operating at constant potential for several years. In this connection new means were developed for suppressing the electronic faults. These methods have proved entirely successful and have been adopted in later installations.

Figure 2 shows a simplified diagram of an electronic converter of this type used for d-c transmission and frequency conversion. It should be noted that the power circuits of the rectifier and the inverter are identical and that it is the grid control which makes one part of the whole into a rectifier and the other into an inverter. By change of the grid controls, the power flow can be reversed. The rectifier and the inverter are however not independent devices like a generator and a motor but function together as a whole — the electronic converter. Electronic faults which occur in the inverter are suppressed by the rectifier. The rectifier suppresses its own faults but even this statement must be accepted with some qualifications. The rectifier can suppress its own faults because the inverter cannot feed current back into the rectifier but if several rectifiers feed the same circuit in multiple they can feed current into each other's faults and therefore fault suppression depends upon interaction between the several rectifiers.

The Single Conversion Frequency Changer

Another type of electronic converter is shown in Fig. 3. It is the frequency changer used with the thyratron motor.

Features of the 20,000-kw Electronic Power Converter at the Edgar Thompson Plant of Carnegie-Illinois Steel Co.

The 20,000-kw Electronic Power Converter installed by the General Electric Co. at the Edgar Thompson Plant consists of two complete 10,000-kw units. It is designed to exchange power, reversibly, between 25-cycle, 44-kv and 60-cycle, 69-kv systems.

Four pentode-ignitron tube groups of six tubes each make up a unit. The tubes used are the GL-506 which were specially designed for rectifier and converter service. This tube is an ignitron of the permanently evacuated, sealed steel type, having the control characteristics of a thyratron tube.

Physically, the tube is of cylindrical shape, approximately 10 in. in diam, 45 in. long, and it weighs 100 lb. A view of one of these tubes is shown in Fig. 5. Two concentric stainless steel cylinders form the enclosing envelope. Water circulates in the annular space between the cylinders to remove the heat losses. Internally, the tube comprises 5 elements, hence the name "pentode". There are three grids, an anode, and a mercury pool cathode.

The tubes, together with a box of ignitor and grid control apparatus, are mounted on a platform insulated from ground. On top of the grid box is mounted the potential dividing resistor rack which keeps the intermediate anode at a potential halfway between anode and cathode. On the back of the grid box is mounted the filter capacitor which connects to the filter resistor located in the top of the cubicle. There is one filter capacitor and resistance for each tube.

Twelve tubes form the rectifying element for converting 10,000-kw alternating current into direct, and 12 additional tubes convert the direct into alternating current. The direct-current link operates at approximately 30,000 v. When changing from rectifier to inverter operation for reverse power flow, the phase position of the grid voltage must be shifted by approximately 150 deg. This function is performed by the phase shift network.

In operation, the electronic converter is held to a constant power output independently of relative system frequencies and voltages and can be reversed by selection of control circuits.

It contributes no current to faults in the supply system, little more than load current to receiving system faults, while controls suppress power flow to internal faults. Switching is resorted to only for persistent faults. Reactive overexcited current is supplied by synchronous apparatus of both systems, excess losses of which are chargeable to the converter. Efficiencies remain high throughout the load range.

Switchgear and control devices for this Electronic Power Converter present new opportunities for the switchgear designer. The ease with which the converter is switched into and out of service and its output controlled present the possibility of providing simple and at the same time versatile controls by means of which the operator can make the fullest use of the converter, in meeting the various demands of his system. Protective relaying of the electronic converter against system disturbance is simple.

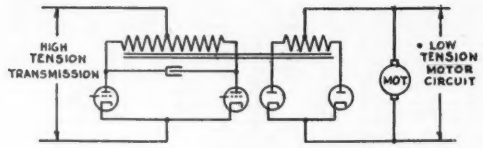


Fig. 4. D-c Transformer

This electronic converter has not yet been given a name by which it can be readily identified. It is proposed here that it be known as the single conversion frequency changer. The energy is converted by electronic means only once whereas in the dual conversion type of frequency changer the power is first converted into direct current and then back to alternating current. Both function in the same way as a non-synchronous tie between two a-c systems. Besides this, the single conversion type has many desirable characteristics, such as being adapted to feed a stub end load. The motor for which it was originally developed is a stub end load and starts from standstill with a good torque like a d-c motor. The single motor may be replaced by a synchronous condenser and an independent distribution system including a multiplicity of motors.

The problem of suppressing electronic faults in this type of electronic converter is solved quite easily. When for one reason or another a loss of grid control occurs in one of the tubes the resulting disturbance lasts only one-half cycle because each tube is a rectifier as well as an inverter and the rectifier function commutates the fault current out of the tube where the fault occurred. The practical result is that this type of electronic converter is entirely free from the problem known as shoot-through in the simple inverter. Thus it will continue to function with slightly reduced power even if several tubes are disconnected, whereas the simple inverter becomes inoperative if a single tube fails to function.

The D-C Transformer

One of the first objectives in the development of the inverter was to provide a way for transforming direct current from high tension to low tension. D-c transformation has not yet found application in any large scale. But the experience gained in d-c power transmission indicates that from a technical point of view it is entirely practical. The electronic industry is waiting for a demand where this experience can be applied. The questions that are likely to be asked are: How will it start? Will it require moving machinery? How will it ride through faults?

In order to give a practical answer to these questions, tests have been made represented by the diagram Fig. 4 and oscillograms, Fig. 6. The power source is assumed to be a rectifier station like the one used in the d-c transmission from Mechanicville to Schenectady. The receiving station has no moving parts. It has a step down transformer from the high tension inverter to the low tension rectifier. A capacitor is in shunt with the transformer. The load is a d-c motor. One oscillogram shows how the operation is initiated from a dead start by application of the grid control to the high tension inverter. A second oscillogram shows the characteristic wave shapes.

Adaptability of the Electronic Converter

In practical operation of any of these types of converters described in addition to electronic faults there are also likely to be circuit faults. The d-c transmission line for instance, is sometimes struck by lightning. The short circuit following a lightning stroke is cleared by the control system which is provided for suppressing electronic faults. The transmission line is therefore immune to lightning strokes so long as permanent damage is not done to the insulators. In the design of the electronic converter a virtue has thus been made of a necessity and a real improvement in practical reliability has resulted. Disturbance from other causes than lightning may result in circuit faults. Whether such faults can be counted on

Fig. 5. G.E. Pentode-Ignitron, Type GL-506

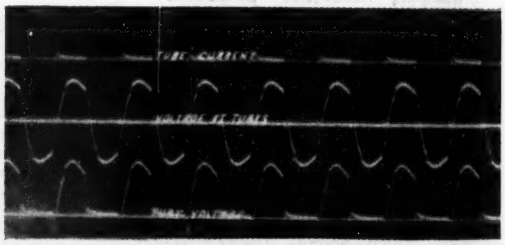


Fig. 6a. Wave shapes of inverter in d-c transformer

Fig. 6b. Wave shapes of rectifier in d-c transformer

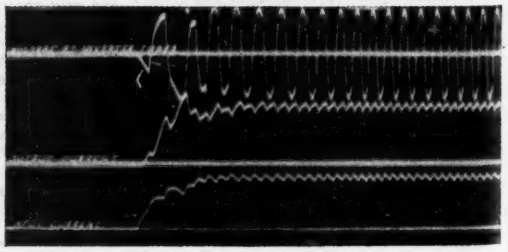


Fig. 6c. D-c transformer starting a motor load

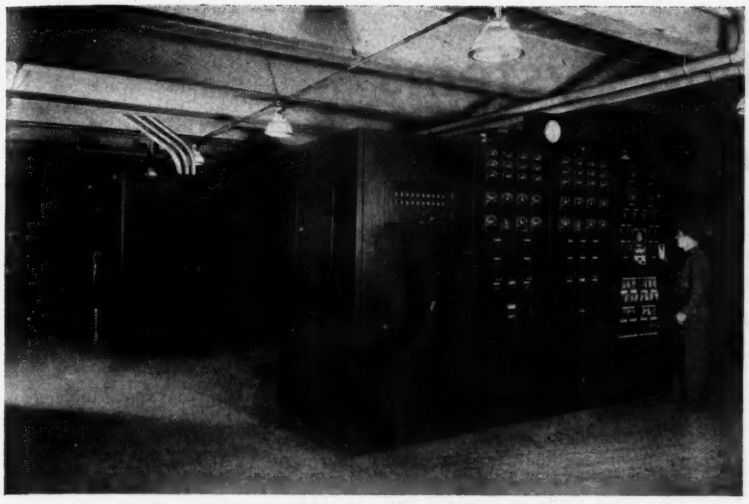


Fig. 7. Controls and test panels of the 20,000-kw Electronic Power Converter at the Edgar Thompson Plant

to clear themselves automatically depends upon the characteristics and stability of the systems that are involved. An electronic converter has a definite load limit like an inductance motor or a synchronous motor. In the grid control we have however excellent means for regulating the system so that those load limits are never exceeded. Such regulating systems have been incorporated in the installation installed at the Edgar Thompson plant.

It is important that the application engineer should understand the characteristics and limitations of the several types of electronic converter.

The rectifier inverter combination may be described as a frequency changer or a d-c power transmission depending upon whether they are located in the same station or far apart and joined by a d-c transmission line. The Mechanicville-Schenectady installation is a frequency changer as well as a transmission because the power is generated at 40 cycles and delivered at 60 cycles. Similar installations may fill a demand in the future as non-synchronous links between 60 cycle systems which are not operated in synchronism. This type of installation is primarily adapted to exchange of power between independent systems. In its original form, it is not adapted to start a dead load. When needed, however, suitable arrangements will undoubtedly be made. An electronic d-c transformer fed from a d-c line may be used to start a dead load. The power thus made available may be used to start a synchronous condenser so that it can be fed from another electronic converter. This will serve to illustrate many possibilities of using the electronic power converter in one form or another. It can safely be said that with the installations of the electronic power converter already made, this new tool of the electrical industry has come out of its infancy.

Centrifugal Pump Control

(*Continued on page 76*)

perfect correlation of calculated and actual results. Likewise, pump areas may impose very definite limitations under excessive speed increases. A 3-in. pump, for instance, designed to deliver 500 gpm at a speed of 1000 rpm, would theoretically deliver 3000 gpm at a speed of 6000 rpm, except that the resulting velocities through the various pump passages would become excessive and the capacity-speed relationship established above would probably break down before this speed of 6000 rpm would be reached.

Pressures and Heads

In this question of centrifugal pump characteristics, it is also necessary to differentiate between pressures and heads. The former are generally expressed in pounds per square inch above some datum line, such as absolute zero or atmospheric pressure. Heads are expressed in feet of the liquid pumped. When referring to pump discharge or suction conditions they are generally determined with atmospheric pressure as the datum line. Thus, if the discharge head is 250 ft, it is implied that the 250 ft are measured above the atmospheric pressure. If the pump is handling a 15-ft suction lift, reference is made to a negative suction head of 15 ft below the atmospheric pressure.

Meaning of "Total Head"

When, on the other hand, one speaks of "total head," this head is the algebraic difference between discharge and suction heads (both referred to a common datum, of course) and, as such, is an absolute value, referred to no datum. While system heads may frequently be expressed in pounds per square inch pressures, especially if a definite pressure is to be maintained in a system, it is preferable to convert them into feet of head for the purpose of selecting and applying centrifugal pumping equipment, because a given centrifugal pump, operating at a given speed, will generate a definite total head in feet of the liquid pumped, regardless of the gravity of the fluid, and therefore will develop varying pressures with various fluids.

The average engineer generally has difficulties in dissociating his mind from the conventional total head-capacity characteristic plotted at constant speed. This curve in itself cannot always serve alone in determining the operating characteristics of a pump in a given system. In the first place, in most systems it is desired to maintain some terminal static head or static pressure in the discharge and it is then the intersection of the discharge head and not of the total head curve with the system head curve which determines the operating conditions. Since the suction conditions may vary at different times or even at different rates of flow, it becomes frequently necessary to replot the head-capacity curve in terms of discharge head or else convert the usual system head curve into a required total head curve by subtracting the suction head from the system discharge head.

In addition, as it has just been seen, centrifugal pumps are frequently operated at variable speed and the constant speed characteristic of the pump is of no value other than in determining the speed at which the pump must operate to develop a given total head at a given capacity.

Once the principles underlying centrifugal pump characteristics and the effect of speed changes on pump performance are thoroughly understood, it becomes necessary to analyze the fundamental functions which centrifugal pump controls may be required to fulfill, and these fundamental control functions will, therefore, form the subject of the next article.

(To be continued)

Water Power Operated Air Compressors

(*Continued from page 77*)

pipes, each 44 in. in diameter. The size of the heads is reduced in diam to about 8 ft, and the whole apparatus can be raised or lowered as required by the operating conditions. A cone A assists in separating the water and the air, and the long horizontal tunnel permits almost complete separation. The compressed air is removed through the pipe C and the water freed from the entrained air which escapes through the vertical shaft B. The pipe E acts as a relief valve for a surplus of compressed air. Its end is normally below the surface of the water in the tunnel, but if the amount of air should accumulate it would be exposed and permit the escape of the surplus air without seriously affecting the normal air pressure in the system.

Radiant Heating Systems Advance Human Comfort

Principles of radiant heating are centuries old but experimental data were not obtained until about 36 yr ago . . . Properly designed system gives sensation of gentle warmth . . . Floor type coils are easiest to apply . . . Heat loss calculations similar to conventional systems . . . Heating coils in concrete slabs . . . Insulation precautions . . . Economy indicated

By Charles Hawk, Engineering Service Department, A. M. Byers Co.

RADIANT heating, in the final analysis, is nothing more than a system of producing comfort conditions by means of large, warm, room surface areas instead of depending on the movement of relatively high-temperature air currents.

When described this way, a radiant heating system doesn't seem to be much different from a conventional system, but suppose we look at the conditions which prevail in spaces heated by ordinary means. Regardless of the type of convection system, no direct attention is given to cold room surfaces such as outside walls, ceilings, etc., with the result that heat loss by radiation from the body is often greater than is comfortable even though the air is quite warm. A good example of this condition is the "Cold 70" with which you are all familiar.

In a radiant heating system the temperature of these cold surfaces is raised—either directly or by reradiation—and thus the body's radiant heat loss is held at a comfortable level. The importance of this method of approach to the comfort problem is obvious when you consider that the major portion of the heat dissipated from the body is in the form of radiation loss—something in the neighborhood of 50 to 60 per cent of the total heat given off. This simply means that once an accurate control is established over the radiating factor, the comfort problem is near to being solved.

This basic fact is absolutely necessary to an understanding of the principles of radiant heating and is the major reason for the tremendous enthusiasm of those people who live or work in radiant heated spaces. These people become used to conditions in which the heating system behaves much the same as the reradiation of electric lights. It produces a sensation of gentle warmth such as that experienced on a bright spring day—there is no sensation of stuffiness, cooked air, or drafts.

The basic principles of radiant heating have been known for many, many years. There is evidence in some of the old ruins on the British Isles that the ancient Roman conquerors employed a form of radiant heat by running the flues from their fires under the floors and around the walls. However, the idea remained unused as far as anyone can discover, until about 36 yr ago when an English heating engineer began to experiment. Since that time a great many installations in all types of structures have been made in England and on the continent. About 16 yr ago American engineers began to make practical use of the system but the idea made very little headway until about 7 or 8 yr ago. The A. M. Byers Co. watched the progress of the system very closely since the first installation in this country, because it was felt to be a natural market for wrought iron. Bit by bit little isolated scraps of information were accumulated and pieced together, some basic research was performed directly and in collaboration with others, and a very thorough and consistent study of the principles involved has been carried out. Accurate case histories have been kept of several hundred installations so that the information given here is in the form of a report on a successful technique rather than anyone's opinions or guesses.

Application of Radiant Heating

Experience seems to indicate that the simplest and easiest method of accomplishing radiant heating is to place pipe coils or grids in the floor and pass hot water through the pipes. The pipe runs may, of course, be placed in the walls or celings but we have come to feel that the floor type system is the first choice with the ceiling coil in the position of second choice and wall coils only in a supplementary capacity to either of these. For this reason, comments here are confined to the floor type system.

In the structural sense, the floor type radiant heating system is exactly the same as the conventional forced hot water system except that pipe coils are substituted for radiators. The same boilers, expansion tanks, circulators, etc. are used, and you may safely consider the integration of these elements to be exactly the same for the radiant heating system as for the conventional hot water system.

The matter of calculation for a radiant heating system is not as intricate as you might believe. The principles are firmly established and begin, naturally, with an accurate calculation of heat loss from the space under consideration. The "AIHVE Guide" covers this type of calculation very thoroughly. The difference in calculation for a conventional system and a radiant system occurs when you begin the calculation of heat input to balance this loss and here's the fundamental trick: for a conventional system you're used to thinking of output from equipment such as radiators only in terms of losses to air at a given temperature. In a radiant system, two kinds of losses or output from the warmed surfaces are considered—the losses by radiation to the cooler room surfaces and the loss by convection to the air.

After calculations have determined the physical characteristics of any particular radiant heating system, the next problem is to integrate the pipe coils or grids into the structure being planned. Most of the radiant systems which have been used in this country have incorporated heating coils in concrete slabs which may or may not be on the ground. The thickness of the slab is of no great consequence since there is ample evidence to prove that the system works equally well with slabs ranging from 3 to 8 or 10 in. The pipe coils may be either encased within the concrete, in contact with the lower surface, or several inches below, embedded in gravel or crushed stone.

I should like, however, to drop a word of warning about slag construction in connection with ground moisture. Concrete is a relatively porous material which will absorb a considerable amount of water coming from either surface sources or rock formations. For this reason it is important that suitable precautions be taken to insure a dry floor. In any case, it is our recommendation that a 6 or 8 in. course of gravel or crushed stone be placed under the slab, with a water proofing seal included between the two elements in locations where there is any reason to suspect the presence of appreciable water. Of course, good drainage practice such as would normally be followed under and around the foundation of any structure is definitely advised.

The actual pipe runs usually take the form of sinuous coils, or grids, in

which a supply manifold concurrently feeds a number of runs which feed into a return manifold. Both types have their individual merits. The sinuous coil is usually less expensive to fabricate and a little easier to design. The frictional head developed, however, usually climbs so rapidly with increases in the total length that the range of practical working pressures limit this type of coil to either small structures or small areas of large structures. The grid type coil, although normally requiring a few more welds, embodies better hydraulic and thermal distribution characteristics. The vagaries of individual designs prevent making any broad statements as to the relative merits of the two coils but it would be safe to say that the grid type coil is generally adaptable to large structures and the sinuous coil to small ones.

Insulation

The question of insulation against downward heat flow from pipe coils placed on or near the ground is not as serious as many people believe. It is not quite possible to determine the exact amount of this loss but some general calculations can be made. These indicate that approximately 30 per cent of the total heat input will be dissipated to the ground in uninsulated installations while a figure of 20 per cent is fairly accurate for cases in which insulation is used. This may seem a little high at first glance but the percentages are based on a total heat loss for the room or structure which does not include any heat losses downward. This factor would greatly reduce the percentages just mentioned when a comparison is made of downward heat losses from the conventionally heated structure. Furthermore, experience tends to indicate that these assumed rates of downward heat loss are very generous and that in actual practice they are much less than the figures I have given. At any rate, we recommend continuing their use.

Considering this experience, the designer's question of whether to use insulation under the pipes becomes largely a matter of achieving results in keeping with the economic characteristics of the structure.

The matter of venting the pipe coils of a radiant heating system seems to be one of personal opinion. Actual installations are about equally divided between those which incorporate air vents from the pipes and those systems which are vented only at the expansion tank. A great many authorities insist that vents be provided while just as many equally good authorities contend that a low velocity, low temperature, forced system does not require venting at any point except the expansion tank. So far we have heard of only one installation made without vents which seemed to suffer to any degree as a result. This particular installation embodied coils on four different levels—a single closed system in which the highest coil was farthest from the boiler. Apparently an air lock developed because circulation in this highest coil was resumed as soon as a vent was tapped into the high spot.

Present practice seems to be to lay coils or grids level and depend on the action of a circulator for drainage. My own opinion is that a level coil can be adequately drained by means of a circulator and that this procedure is superior because it automatically eliminates the structural and thermal problems inherent in sloped systems.

Forced Circulation

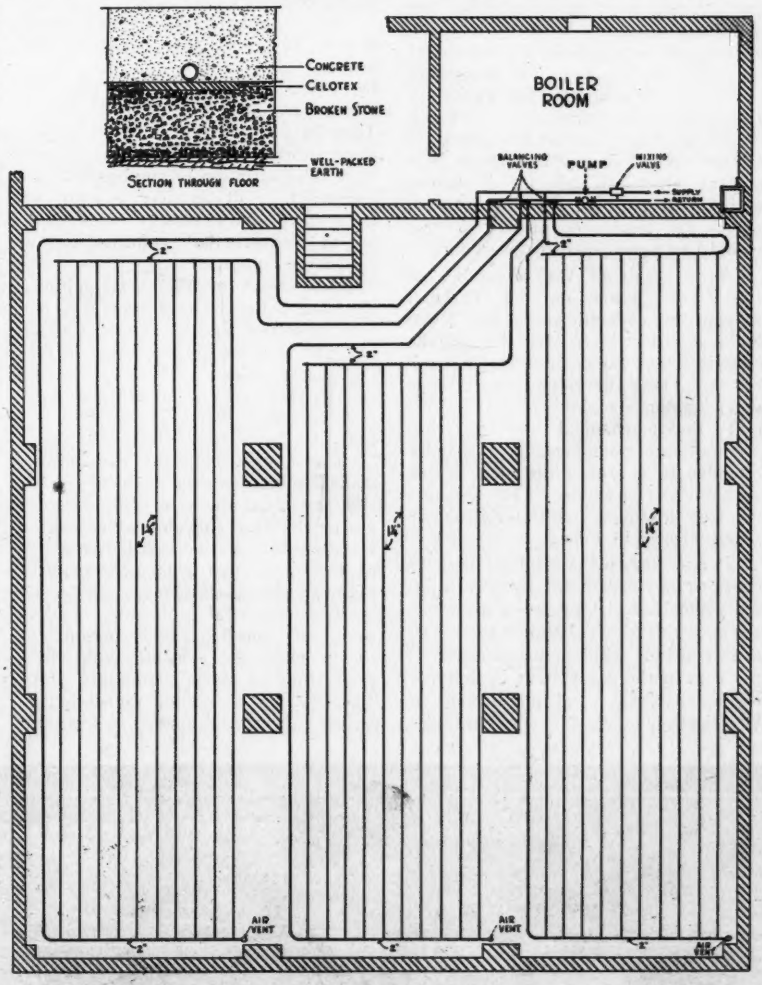
Care should be taken to choose a circulator pump of sufficient capacity rather than to resort to the fairly common practice of saving a few dollars by the use of an undersized pump. Certainly the installation of a pump of the right size would seem to be absolutely necessary in a well-engineered installation.

Among the questions most often asked about floor type systems are "Doesn't the floor get too hot?" and "Will it work with wood floors or rugs?" The answer to the first question is that a properly designed system will never produce floor surface temperatures above 85 F and this temperature—based on the experience of hundreds of installationss—is not excessive. As a matter of fact, it is almost impossible to tell where the heat is coming from in a properly designed installation even though floor temperatures do reach 85 F. This surface temperature question also bears a relation to the question of floor construction and coverings. I believe it is safe, however, to assume—again basing the assumption on the results of a great many installations involving all types of floor construction and coverings—that just about any of the common materials can be used.

The matter of insulation is one which should receive just as much attention in a radiant system as is given to the same problem when a conventional heating system is used. There is no economic justification for heating large portions of the great outdoors. Thus, a few dollars' worth of insulating materials really constitutes an ounce of prevention.

A somewhat unlooked-for characteristic of radiant heated space is that air temperatures closely follow the

(*Continued on page* 91)



Typical layout of radiant heating coils in concrete floor laid on earth

The Mechanical-Electrical Dust Collector

New duplex unit employs primary mechanical collector unit to collect coarse particles from flue gas or waste gases, by-passes portion of gases to secondary electrical collector for final removal of fine dust. Overall efficiencies of 90 to 94 per cent claimed for the combination

DURING the past few years, both mechanical and electrical types of dust collectors have reached a relatively high degree of development. Not only has there been a need to reduce the emission of fly-ash from power plants but also there have been developed new industrial processes in which recovery of solid particles from gases may be a part of the process, may be desirable to recover valuable materials, or may eliminate an undesirable pollution of the atmosphere.

Mechanical types of collectors have been developed to the point where their manufacturers demonstrate that they extract very high percentages of the coarse particles, those above 10 to 20 microns in size, while the electrical types of collectors have been extremely effective in collecting the fine uniformly sized dust below 10 microns. To many engineers, it has seemed that the ideal collector would consist of a mechanical and an electrical collector in series, each handling all the gas to be cleaned, yet it has been recognized that this would be a very expensive procedure.

As a result of the researches of Prat-Daniel Corp. on the Thermix tubular dust collector and of the Westinghouse Electric & Mfg. Co. on the electrical type collector, a duplex unit has now been developed to combine the advantages of both types. In this unit, the mechanical and electrical methods are combined in a manner intended to approach the ideal yet be economically feasible. The arrangement of this duplex collector is shown schematically in Fig. 2.

It operates on the principle that the gases to be cleaned pass through a primary mechanical type collector, where the particles above 10 microns in size are removed, while approximately 15 per cent of the gas volume is skimmed off mechanically, and directed to an electrical type collector, where the high efficiency of collection of this unit collects the very fine particles.

The primary section, consisting of the Thermix tubular collector as shown in Fig. 1, has shown efficiencies on test, cleaning gas from typical pulverized coal installations, of approximately 82 per cent. This means that 18 per cent of the solids are entrained in the flue gas pass to the atmosphere.

Under most conditions, such operation is acceptable and alleviates the dust nuisance, for the average fineness of the emission is 10 microns or less. However, new and more severe dust prevention ordinances may require higher collection efficiencies.

Assuming that a collection efficiency of only 70 per cent is possible in the primary mechanical collector, then 18×0.70 or 12.6 per cent of the dust would pass to the electrical collector. Tests have shown that this dust is usually uniform in size and in carbon content. The variation in combustible encountered in all furnaces is provided for in the primary collector. Dust passing to the secondary collector is low in carbon content.

Field tests of the Westinghouse electrical collector have shown 96 per cent collection and if 12.6×0.96 or 12.1 per cent were precipitated in this secondary collector, the overall efficiency of collection of the combined units would be $82 + 12.1$ or 94.1 per cent.

The duplex collector can be installed with provision made in its design for initial omission of the secondary or electrical collector which can be installed later if increased stringency of dust prevention ordinances requires highest cleaning efficiency.

The electrical collector requires periodical servicing, the periods of which may not coincide with shut-down time of steam generating units. Large steam generating units, in particular, operate without shut-down for a long time. The duplex collector design, however, permits the electrical unit to be bypassed at any time and taken out of service for maintenance, the primary or mechanical section remaining continuously in the line to prevent a dust nuisance.

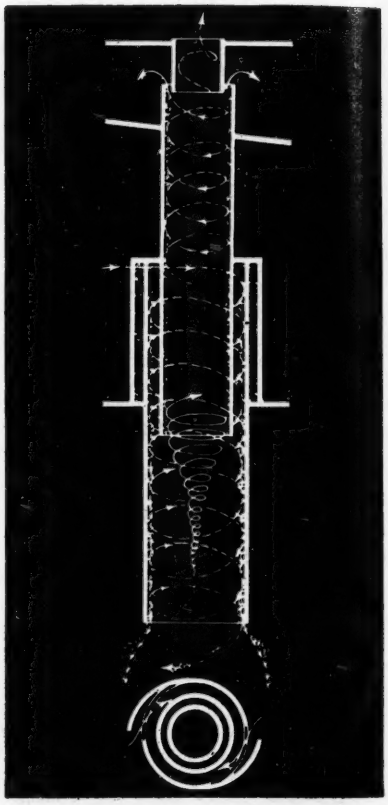
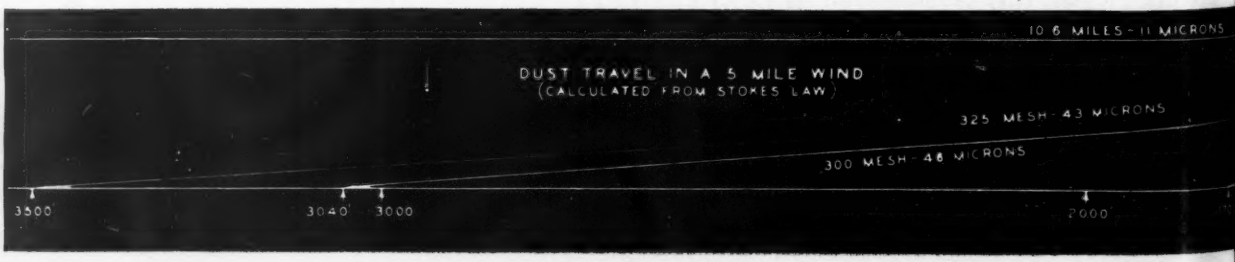


Fig. 1. Diagram showing operation of Thermix tubular collector as used in primary section

When both sections are in service, the gas volume passed to the secondary may be varied to suit conditions. Depending on the fineness of dust and the amount of gas skimmed, from 50 to 90 per cent of the dust lost by the primary section can be concentrated in the skimmed-off gas stream.

At the conclusion of the original



research on this unit, a commercial size model was tested under simulated field conditions in the laboratory. As a result of these tests a pilot plant was constructed in connection with the new 900,000 lb-per-hr steam generating unit at the Huntley Station of Buffalo-Niagara Electric Corp. This unit was already equipped with a standard Thermix tubular dust collector, so that it was feasible to install the duplex section with minimum effort. Tests on this pilot plant led to the decision to equip one-quarter of the existing 900,000 lb-per-hr unit with this design. Restriction of materials delayed this installation somewhat, but WPB recognized its importance in looking to post-war problems and granted necessary priorities. This collector unit is to be placed in operation soon.

As an illustration of the relative fineness of dust and its travel under wind velocities, Fig. 3 has been prepared by Prat-Daniel Corp.

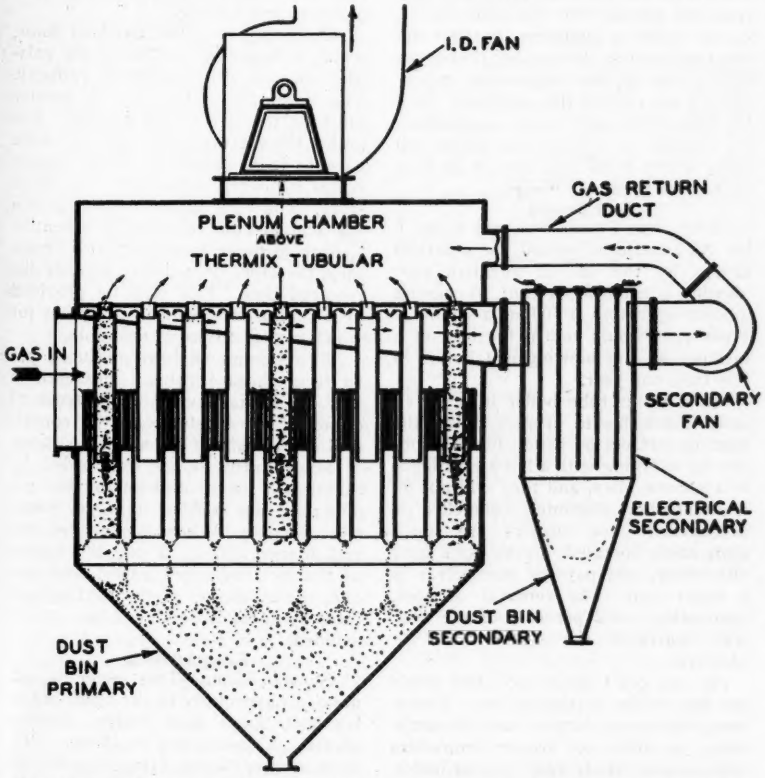


Fig. 2 (Above). Schematic diagram of duplex collector, showing primary and secondary sections

Radiant Heating Systems Advance Human Comfort

(*Continued from Page* 89)

mean radiant temperature. This means that the ordinary room thermostat will provide a thoroughly suitable means of control. In most systems, thermostats of this type are wired to the circulator and close observation adequately proves this control scheme to be satisfactory. As a matter of fact, control design in a radiant heating system is subject to exactly the same latitude that is available for the conventional forced hot water system. Such devices as boiler water aquastats, anticipating thermostats, mixer valves, etc., will add just as much to a radiant system as they will to any other but their use is no more necessary than is normally the case.

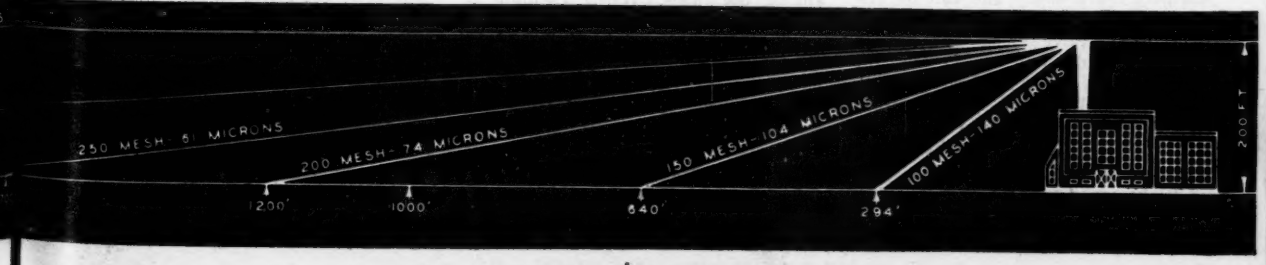
It has been rather difficult to get actual dollars-and-cents "first costs" on a comparative basis for obvious reasons. Once any type of system is installed in a given structure, the comparative cost of any other system for that same structure can be based only on necessarily inexact estimates. In this connection, radiant heating estimates are sometimes deceptive due to inexperience on the part of the contractor or fabricator who fears that he is getting into something deep, dark, and mysterious, and therefore leaves a very comfortable pad to protect himself.

For example, we have on our records the case of a house recently built in Illinois in which the architects wanted to use radiant heating. They collaborated with a local engineer, worked out a suitable system and then submitted it to a heating contractor for a bid. He flatly refused to have anything to do with such quackery so the architects said, "All right, we'll be our own heating contractors." They proposed to use a sinuous coil and, to have this work done, they asked a number of local fabricators to submit bids for the pipe bending. As a result, the lowest quotation they got was $1.50 per bend of 1½ in. pipe. They felt this was a little on the high side and decided to do the bending themselves on a homemade jig. For their own records they made an accurate time-study and found that they averaged five minutes per bend from the time they took a length of pipe from the stock pile, measured it, bent it, took it into the house, and returned for another length.

Of course it goes without saying that when comparing the cost of any two heating systems care should be taken to see that the comparison is made on an equal basis. Where such refinements as zone control, anticipating thermostats, aquastats, etc., are involved, they should be either allowed for or included in all systems being studied.

Comparative operating costs have also been a little hard to pin down but we have developed considerable data to indicate that measurable economy can be expected.

Fig. 3 (Below). Diagram showing dust travel of particles of various sizes from 140 microns to 11 microns in a 5 mile per hr wind



Fundamental Facts About Fuel Efficiency

A collection of letters prepared and presented as a war-time service to fuel users, dealing in a non-technical way with subjects bearing directly on efficient operation of fuel-using equipment. These letters are being distributed in the Chicago area by the Chicago Advisory Council as part of the National Fuel Efficiency Program now being conducted

By Joseph Harrington, Advisory Engineer, Coal and Its Uses

NO INDUSTRY can produce an ounce of anything without the heat, light, or power that originate in the burning of fuel. The importance of the boiler room to American industry cannot be overemphasized; and since American industry is back of every nut and bolt, airplane, tank, or machine tool—back of every ounce of medical supplies, explosives, or battleships—the boiler room takes on an importance seldom appreciated by the layman.

Next to the mere production of power comes the efficiency of its production. Every manager, engineer, fireman, is vitally interested in efficiency. A ton of coal saved from waste is better than a ton produced. The miner is relieved from producing a ton, the railroad from transporting it, the fireman from shoveling it, and, last but not least, the management is relieved from paying for it. Above all stands the fact that, saved from waste, that ton of coal will be converted into the essential needs of war and the comfort of humanity.

It is well for us to take a look at our boiler room. Do we realize that the boiler room is a complete factory in itself, converting the stored up energy in the fuel into the active, restless energy of steam? Steam is the finished product of this "factory". It is well to study the elements surrounding its making.

But before going into details, let's put our house in order. We can't work in a dirty shop. Clean up the boiler room. Dispose of that stuff behind the boiler; make sure the place is adequately lighted; repair the stokers or grates wherever needed; seal up those cracks around the doors and in the brickwork; see that fire and soot blowing doors fit tight; that the boiler dampers move easily and can be fastened in any position; that the boiler pumps and valve stems are packed. Take a lighted candle and go over the boiler setting. At every crack or leak the flame will draw in. Don't assume that everything is tight. You may be surprised! We want a tight setting when we study gas analysis.

Light up—clean up—check up. Then we can get down to the serious business of saving fuel.

Soot is one of the most efficient insulating materials known, and it has a remarkable affinity for attaching itself to boiler tubes. It is the one ever-present and ever-increasing enemy of efficiency. Soot begins to form the moment after the previous layer has been removed, and in 6 hr the soot deposit in any boiler is sufficient to affect the flue temperature. Remember that every 33 deg rise in flue temperature represents 1 per cent of the coal fired. In 8 hr, even with fairly clean combustion, the deposit of soot on the tubes will cause a rise of 50 deg; and in 24 hr it may cause a rise of 100 deg.

Soot Blowing

Soot should be blown out every 6 hr. As a matter of record, the observed saving by the use of effective soot blowing is often 3 per cent. Assuming a boiler operating at 500 hp, a saving of 3 per cent would return the cost of a mechanical soot blowing installation in less than one year.

In a water tube boiler it is physically impossible to properly clean the heating surfaces by hand. Firemen object to wrestling with a hot steam lance in a narrow alley, and they will not do it oftener than absolutely compelled to. Mechanical soot blowers are much more easily operated; do the work more effectively; and pay for themselves in a short time. The removal of soot, accounting for 2 per cent of the coal, well warrants the expenditure for blowers.

If you don't make soot, you won't get any on the heating surface. Therefore, watch your furnace, and do everything possible to secure smokeless combustion. Study your type of boiler, and find out where the lodgment of soot is easy; and then give special attention to these points. Boilers differ greatly in their tendency to retain soot among the tubes. Where cleaning is difficult, extra effort is required. But get it clean. Remember also that soot not only acts as an insulator, but, when wet by steam condensation or leakage, produces an acid which will corrode the heating surface in contact therewith. Soot is your constant enemy. No trouble is so great as to warrant your neglecting this matter. Eternal vigilance is the price of efficiency.

In low pressure plants, automatic soot blowing of course is impossible, and hand cleaning must be resorted to.

Furnace Capacity

Furnace capacity is measured by the amount of coal that can be burned completely with the least amount of air. Both the shape of the furnace and the method of firing affect the capacity.

When a shovelful of coal is thrown onto a hot fire, there is very rapid liberation of the gaseous part. This gas is a rich combustible which burns in the furnace when the proper temperature and air mixture is present. But if several shovelfuls are thrown on in quick succession, so much gas is produced that it cannot all burn up in the furnace, and the "capacity" is exceeded. This means smoke and fuel loss.

Stokers introduce coal with greater uniformity and in smaller amounts per unit of time than the equivalent hand firing, and for this reason stokers will produce smokeless combustion in a furnace that would be overloaded at times of heavy hand firing.

Obviously, also, the length of flame, which is largely a function of the volatile content, affects furnace capacity. The more gaseous the fuel, the greater must be the size of the furnace. The higher the volatile in the coal, the more gaseous is its character. Mere volume is too frequently considered the whole story. The time element entering into the combustion reaction is essential. Length of flame travel becomes necessary, therefore, in order to provide the required time. This may be provided by a skillful arrangement of arches for which expert advice is desirable.

The amount of heat produced per cu ft of furnace volume measured in Btu per hr is a valuable measure of capacity, but must always be considered in the light of furnace proportions.

Many furnaces are overloaded by asking too much of them, by the use of wrong size coal, or improper methods of firing. When this occurs two fuel losses follow: First, the escape of the rich unburned gases; and second, the insulation of the heating surfaces by soot. Both should and can be avoided.

Firing Methods

Shovel Firing—This letter is addressed particularly to the small industry with hand fired boilers, heating plants, and apartment buildings. Efficient and smokeless firing of soft coal is an art, and requires skill and understanding on the part of the fireman. Our old friend, Joe Hays, builder of the draft gages, coined the phrase, "Fire little and often, fill the holes, and watch the water". This just about sums up the whole thing!

Remember that combustion can proceed only when there is a proper mixture of air with the combustibles, a temperature high enough to permit the gases to burn, and time enough for the burning to be completed before the gases reach a cold spot. There are several variations in the method of accomplishing this.

Coking Method—In order to distill off the volatile combustibles slowly, so that they can all burn up in the furnace, the coal is piled up on the dead plate just inside the fire door. The heat from the live fire cokes this coal and furnishes the conditions necessary for burning gases as they slowly leave the pile of coal. After a while, depending on the rate of heat production desired, the pile of coke is pushed back and spread out over the grate. It is now practically smokeless, and the coke burns brightly and makes steam while supplying the temperature to burn the gases from the fresh pile of coal on the dead plate. This system works well in firebox boilers in apartment buildings.

Spread Firing, Alternate Method—In this system the fresh fuel is fired on one side of the grate and then on the other, alternately as often as required. The bright half of the fire furnishes the heat to burn the gases from the fresh fuel on the other side.

Spread Firing, Quartering Method—With heavy loads it sometimes happens that the alternate method does not produce enough mixing effect to burn all the fresh gases. In such cases it is well to fire the back half of one side and the front half of the other side at one firing. Then the next time cover the other two quarters. This tends to reduce the area covered by an unbroken layer of coal, and effect a better mixing of the gases with air.

Remember the three T's: Time, Temperature, and Turbulence, necessary to efficient combustion.

Overfire Air

The need of supplying enough air for complete combustion of any fuel is so elementary that it requires no argument, but just how that air shall be introduced and mixed with the fuel is still one of the livest and most important problems of combustion engineering. It has within it the possibilities of preventing smoke, of increasing boiler efficiency, of lightening the labor of the fireman, of cutting costs for the management, and saving fuel for the nation.

The Bureau of Mines has determined that only about 7 lb of air per lb of carbon can be passed through a uniform bed of incandescent coke. Yet it requires 11½ lb to effect complete combustion. The rest has to enter the furnace through holes in the fire, at the back end of a chain grate stoker, through open doors in a hand fired furnace, or in other improper ways; or, it may be scientifically introduced over the fire through nozzles suitably placed to provide proper distribution. This overfire air is made to enter the furnace at considerable velocity, so that not only the required weight may be supplied, but that greater turbulence and mixing with the furnace gases will result.

This air may be moved by the well-known motor driven fan or by steam jets. R. B. Engdahl, Battelle Memorial Institute, Columbus, Ohio, has written a comprehensive report on the design of steam jets for overfire air introduction. Every engineer and plant manager should read it. There are also engineering organizations which make a business of designing and supplying this apparatus. Fan manufacturers also are conversant with this problem. Consult one of these.

Many times there is plenty of air in the furnace, but it is all bunched in one spot. This is called stratification of gases, and all that is needed is to mix them all up, and smokelessness will result. "Turbulence" is the answer. The overfire air jet will give this. Install at least two jets, and use them as necessary. You will be pleased with the result.

However, unless due care is taken in the design, installation and use of overfire air jets, too much excess air may be introduced; or, if improperly directed, firebrick erosion may result. For important installations, obtain expert advice to avoid experimentation and undue cost.

Smoke

The smokeless burning of any high volatile fuel, soft coal, oil, or gas, follows certain laws of chemistry that are very simple and perfectly well known. It is in the application of those laws in your furnace that often requires skill and experience. The returns, however, are out of all proportion to the cost, and no trouble or expense should be considered too great to get a clean stack.

This sounds like an extreme statement, but consider the results of black smoke. First, from the standpoint of management, it means absolutely throwing away up to 10 per cent of your coal in unburned combustible. It insulates the heating surface of your boiler so that it will not absorb the heat that is available. It pollutes the atmosphere to an extent that the health of people is seriously affected; and it causes corrosion in exposed metal parts of buildings. Many other things could be said, but this is enough.

It is a fortunate circumstance that complete combustion is efficient combustion; so we are all set to gain from every angle.

Fuel is composed principally of three familiar elements—carbon, hydrogen, and sulfur. These are the parts that burn or unite with oxygen. The result in each case is a colorless gas, so that all we have to do is to completely burn them, and we have smokelessness!

In order to effect complete combustion the conditions are equally simple. They are: (a) the mixing of sufficient air with the combustible gases; (b) the presence of a temperature high enough to permit the chemical union with oxygen to take place, that is, to permit them to burn; and (c) to allow sufficient time for the gases and oxygen to mingle and unite. These are the famous three T's. Stated in the same order as above, Turbulence, Temperature, and Time.

The actual application of these laws to your problem involves a study of the individual furnace. No general rule is possible because every furnace is different. If in Chicago, your Smoke Department is at your service; in other areas, have your Waste Chaser study the problem. There are consulting engineers who can be called upon. The elimination of smoke benefits everyone and saves coal.

The Significance of Draft

No word is used around the boiler room as often as "Draft" and perhaps nothing is more basically important. Yet the real meaning of the word is often misunderstood. A correct understanding may make some puzzling things clear.

Draft is the difference in weight between the column of cold air outside the boiler and the column of hot air (or gas) in the boiler, breeching, and chimney. It's like a pair of balances, with a heavy weight on one side (cold air) and a lighter weight (hot air) on the other. The heavier weight pushes down harder than the lighter one. The cold column pushes down harder than the hot one, and just chases the light one through the fire and up the stack; but in passing through the fuel bed it becomes heated and part of the light column. This makes the operation continuous, and we have the phenomenon of air flow through the fire, furnace, and boiler. Note that draft is merely the unbalanced weight, or impulse, tending to cause a flow of air. It is not the air itself.

With any given temperature difference and height of stack, there is a fixed limit to the draft available. Following a definite physical law, the amount of air this draft will move varies inversely as the resistance, that is, the greater the resistance, the less the flow.

Applying this to your boiler, the fuel bed is the resistance. A heavy fire and high resistance means less air flow and probably unburned fuel. A thin fire, or a hole in it, means low resistance and a lot of excess air going into the furnace. The simple inference, therefore, is that the resistance of the fuel bed is a direct indication of its efficient or inefficient condition.

The boiler itself is another resistance that retards the flow of the gases, and indicates the amount of gas passing. This in turn indicates the rate of steaming, provided the gases are of the right quality as indicated by the fuel bed resistance.

So with nothing more than two draft gages we can, when properly calibrated, get an excellent idea of boiler performance. They cost little, and nothing to operate. Every boiler should have them, and the fireman should keep an eye on them constantly. A simple gage, properly used, is worth a dozen elaborate affairs covered with dust.

Children, Trees, and Power Lines

Warnings of dangerous conditions do not excuse power companies where accidents to children are involved. In this article, Mr. Childs, who is an attorney at law cites several court cases which show how juries and judges regard such accidents when brought into court

By LESLIE CHILDS

CHILDREN, trees, and power lines, constitute a combination that all too frequently flowers into tragedy, litigation, and financial loss. The court reports are freighted with cases of this kind; and a run through them leads to the conclusion that power companies have two strikes on them from the beginning.

The reason is not hard to see. In the first place, a duty to exercise great care in the transmission of electricity is imposed; the propensity of children to climb trees is recognized. Consequently, when a tree climbing child suffers injury by contacting a live wire, there will arise two questions: Was the power company negligent? Was the child contributory negligent?

Jury questions. And, on the record, from the standpoint of the average jury it takes slight evidence to convince it that the power company was negligent. On the other hand, it, seemingly, takes a lot of evidence to persuade such a body that a child of tender years was contributory negligent, to the point of excusing the power company. Illustrations.

Boy, Tree, Live Wire

In one case the defendant, a power company, maintained a high tension wire along the highway that passed plaintiff's farm. At this point the wires passed directly over a walnut tree. The latter was about 17 ft high, and the wires were from a foot to two feet above the highest branches. The wires were not insulated.

On a morning following a rain, plaintiff's son, past 13 yr of age, climbed into this tree to gather walnuts. He had been warned of the danger in defendant's wires. While in this tree, he received an electric shock that proved fatal. Plaintiff sued for damages and was awarded $5000. On appeal the higher court, in affirming the judgment, said:

"Where electrical power lines are extended by, near, or through a tree, a high degree of care is required as children have an aptitude to climb trees. * * * In the case at bar, plaintiff's decedent had been warned of the danger of coming in contact with the electrical wire, but the record fails to show that the boy had knowledge that the current could be transmitted through the branches or leaves of the tree. Whether a boy of this age and experience should have this knowledge is a question upon which different opinions exist. * * *

"In our opinion the negligence of the defendant company also presents a question of fact. It is charged with knowledge that plaintiff and family lived upon the land where the tree was growing; that children are fond of climbing trees and especially those trees that bear nuts; that its wires were not insulated as they passed over the trees; that the tree was not sufficiently trimmed, so that in shaking the limbs it was possible to contact the live wires; and whether the defendant company used the proper degree of care was for the jury to decide. * * * The judgment of the trial court is affirmed." (281 N.W. 632)

In another case, defendant's power line passed in front of the plaintiff's farm house and through a tree. The tree was trimmed in the immediate vicinity of the wire. There was no warning sign on the tree, though there was a sign on a post carrying the wires 29 ft from the tree that recited: "Danger—High Voltage."

The wires were not insulated. The lower branches of the tree were about 5 ft 4 in. from the ground. Plaintiff's 11 yr old son climbed the tree to see a bird's nest, contacted the wire, and was electrocuted. In affirming a judgment for plaintiff for $3300, the higher court reasoned:

What the Court Decided

"Defendant contends that this was a rural line and that insulation was impractical; that the tree was trimmed on the side nearest the wire so that it would be difficult for a person to climb upon that side of the tree; * * * that the wire was 20 ft from the ground; that the tree was high; and that there was no practical means of giving other protection.

"The contentions cannot be sustained. Ordinarily the extent to which wires conveying deadly electric currents should be insulated or otherwise guarded is a jury question. * * * It is a jury question in this case whether it

(*Continued on Page* 134)

SOMETHING NEW FOR JANUARY

Short-cut methods for estimating the performance of automatic extraction steam turbines will be the basis for a new series of articles entitled "Modern Extraction Turbines" which begins in our January issue. To our old readers, this series, by L. E. Newman of General Electric's Turbine Division, will be a continuation of the "Modern Turbine" series that continued through eighteen issues of POWER PLANT ENGINEERING in those remote days before Pearl Harbor. That original series has since become a book, a very excellent book but we want to tell you about the new series—not plug sales for John Wiley & Sons' book.

This new series lets the cat out of the bag. It is the first time that these short-cut methods for estimating performance of modern extraction turbines have been published. They are methods that save you time; they are accurate, and they are easy to understand.

The first article in the January issue will help you get your feet on the ground by reviewing the fundamentals that govern the selection of extraction turbines, the various types available, and the effect of certain factors on their performance.

From then on there are no punches pulled. You'll get methods that will help you estimate performance in half the time your present short-cuts take.

Our guess is that these will be articles that you will want to clip, so we are warning you of their coming. We look forward with pleasure to giving them to you.

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

HOT MUSIC

It has just come to our attention that a phonograph needle rubbing against a wax record may reach a temperature of as much as 2000 deg Fl Strange to say, this does not surprise us in the least; indeed it would seem that some of the stuff we hear coming off phonograph records these days would completely melt the needles.

All kidding aside, however, the statement is correct. Few of us realize the tremendous pressures existing under the point of a phonograph needle. With an ordinary pickup weighing about an ounce, unit pressures of as high as 3000 lb per sq in. are obtained. It is not surprising, therefore, that correspondingly high temperatures are attained at the immediate contact point where the needle touches the disc. Of course, the depth of this temperature is not more than a few molecules in thickness but it exists just the same.

This curious fact about phonograph needle temperatures is one of many interesting facts concerning the mechanism of "Wear" contained in a 46-page booklet recently issued by The Nitralloy Corp., 230 Park Ave., New York. This booklet is one of the most interesting discussions of the subject of wear that we have ever seen. It was written by D. Landau, Industrial Applications Engineer of the Corporation and contains a wealth of information that should be of interest to every engineer. Wear is something we are all concerned with but few of us know much about it from a molecular standpoint. Most of us can understand that hard materials wear away softer materials but it is not so easy to understand how soft materials wear away hard ones. As Mr. Landau points out in his booklet, soft coal wears out hard steel worms on stoker conveyors, and in carpet making, the Stellite bushings in the eyes of needles are worn out by flax thread passing through them. The mechanism of wear, simple as it might appear to be, is fundamentally a very complex and far-reaching affair. AWK

☆

CONTENTS

Smokeless Combustion of Wood Waste 96
By B. H. Whitehouse

Training for Power House Foreman 98
By Tom H. Jones

The Boiler Fireman's Handbook 100
By J. R. Darnell

Practical Hints and Kinks 102
Safety Mirror
Dowel Pin Puller
Gasket Shaver, Made from Odds and Ends
New Type Hydraulic Coupling
Contact Pressure Adjustments

For the Plant Electrician 104
Know Your Pushbutton Circuits for Better Maintenance
By L. E. Markle
Simple Method of Checking P. F. Meters
Radio Noise from Fluorescent Lamps
A-C Arc Welder Demagnetizes Tools
Three-Phase Power Measurement
By C. O. von Dannenberg
Uses Industrial-Truck Battery to Calibrate Shunts

Letters and Comments 108
He Was Fired for Saving Fuel
High Voltage d-c Generators
Excitement in Small Plants

Questions and Answers 110
How Fill Cracks in Concrete Chimney?
Why Couldn't They Magnetize the Wrench?
Should He Install Motor Drive or Direct Turbine Drive?
Why Is Water Level Hard to Control?
More About the Slamming Check Valve in the Compressor Discharge
Why Does Heater Heat When Light Won't Light?
How Calculate Efficiency of This 2500-kw Turbine?
How Much M-H Alkalinity Should This Boiler Water Show?
How Improve This Furnace?

Flow of Steam Through Pipes 118

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

Smokeless Combustion of Wood Waste

Smoke, what it is and how it is formed . . . Conditions which produce smoke in furnaces . . . Nature of luminous flame . . . Prevention of smoke . . . Air admission . . . Temperature conditions . . . Details of experiments with the use of overfire air . . . Methods used . . . Use of spreader stoker . . . Results obtained . . . Important factors in the proper design of furnaces for burning wood waste

By B. H. Whitehouse

Chief Engineer, Prospect Ave. Plant, A. O. Smith Corp., Milwaukee, Wis.

IN APPROACHING this subject of the combustion of wood waste let us consider briefly some of the features of visible smoke, being mindful of the fact that the combustion of wood does not differ greatly from that of coal; the main difference being in the heat and moisture content.

Visible smoke is chiefly composed of minute particles of carbon usually called soot and varying percentages of volatile matter. When examined through a strong microscope the soot seems to be formed in clusters of infinitely small particles of carbon. Because of its size the carbon in this form is easily carried along even with the slowest gas stream.

A large percentage of carbon particles are apparently formed at or near the surface of the fuel bed or pile burning in the furnace, and become heated till they glow brightly and cause a luminous flame to appear in the furnace. Stated otherwise, a luminous flame is nothing more than gas streams carrying particles of glowing carbon.

Conditions Producing Visible Smoke

Although these atoms of carbon and combustible gas are heated to from 2500 F to 3000 F they will burn slowly if at all, if sufficient oxygen is not mixed with them. Luminous flame is not combustible material in the process of burning but carbon particles heated far above their ignition temperature and ready to burn if properly mixed with oxygen. Too often the air above the grates in a furnace is admitted in such a way that its travel is parallel to the flow of carbon and combustible gas and does not mix sufficiently. Under such conditions the combustible leaves the setting and stack as visible smoke.

The importance of obtaining uniform and complete mixing of the combustible and air in the furnace cannot be too strongly stressed. A convincing demonstration of this fact can be made by obtaining a sample of soot and some potassium chlorate crystals $\frac{1}{16}$ to $\frac{1}{32}$ in. in diam and after mixing them place them on a porcelain dish at about 850 F. It will be noted that the potassium chlorate will melt and the soot disappear slowly, indicating very slow oxidation. Take another sample and mix it with finely powdered potassium chlorate and place it on the heated dish. Combustion will be complete with a quick bright flash, indicating the importance of thorough mixing.

The temperature of 850 F is far below that encountered in power furnaces, so it is evident that intimate mixing causes more complete and rapid combustion and the lack of mixing causes visible smoke more often than low temperature.

Prevention of Visible Smoke

Visible smoke can be brought within control by effecting the following conditions to assist in the complete combustion of the combustible *substance in the smoke.*

1. A sufficient supply of free air which is in excess of that required for complete oxidation of all combustible substance in the fuel.
2. Intimate mixing in a suitable chamber of free air with the combustible leaving the fuel bed.
3. Maintaining a temperature above the ignition temperature of the combustible substance while passing through the zone of turbulence.

Air Admission

Very little free oxygen is admitted through the fuel bed. Excess air above the fire is usually supplied through openings in the fire doors, above the doors, or in the dead plates; sometimes through openings in the bridgewall or some combination of these openings. With these methods there is very little turbulence. Intimate mixing with the foregoing methods does not take place as the free air travels a course parallel to that of the combustible and the result is visible smoke in a greater or lesser degree. However, if this excess air is forced into the furnace in opposing cross currents at high velocity, the position of which would be governed by the design of the setting, we have a very different picture. Mixing is accomplished, smoke diminishes and when the proper conditions are reached the smoke disappears.

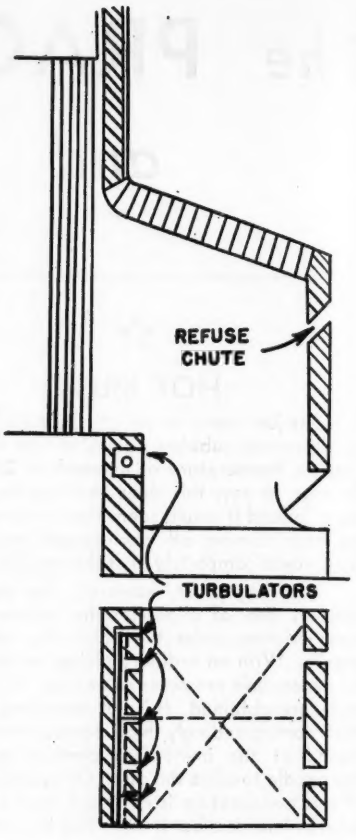


Fig. 1. Details of setting using compressed air to produce turbulence

These high velocity air currents can be created with compressed air or with steam jets. If steam jets are used they should be designed with great care, so they act as an injector with small steam nozzles. In this way they produce the desired effect with a minimum of steam.

Temperature Conditions

The particles of carbon and combustible gases must be heated and kept above their ignition temperature until their intimate mixing with air is accomplished, otherwise the carbon will pass to the chimney as visible smoke and a portion of the gases even though colorless will condense and add to the smoke density.

In most furnaces the temperature is sufficiently high and smoke is usually formed by lack of mixing. However, if there are large portions of the boiler heating surface exposed to the fire, some of the combustible may become cooled to the extent that it will pass off as visible smoke, and the slower the gas movement the more pronounced the smoke condition. It should be noted that smoke is not made by contact between the combustible and heating surface as it is already in existence before contact is made. Construction of brick arches or covering a portion of the boiler heating surface with tile, often improves this condition. The arches also assist the mixing.

In the plants where wood waste is in use, some have a surplus, as in sawmills, where it is burned in some form of the Dutch oven. Such plants are usually located in thinly populated districts and little thought is given either to economy of fuel or smoke, since in any event all fuel cannot be consumed by the furnaces and the excess must be hauled away and disposed of. In this way combustion becomes purely a problem of disposal. The fuel in these plants is usually very high in moisture content.

It is possible to burn hogged fuel with pulverized coal successfully where the two fuels are fed to the furnace through separate burners and where flat grates are provided upon which the wood that does not burn in suspension can lay and burn. Turbulence is well taken care of in such installations.

One setting with which I experimented with compressed air to produce turbulence was a 500 hp Wickes boiler set in a liberally proportioned Dutch oven (Fig. 1). Dry hogged fuel with a small percentage of paper also hogged was stored in a bin from which it could be fed at a uniform rate to the furnace. Ash-pit doors were kept nearly closed and fire doors were opened sufficiently to supply excess air. Air flow was then controlled by the hand dampers. When operating in this way we obtained from 11 per cent to 12 per cent CO_2 when visible smoke commenced. When I applied the turbulators shown, with steam at 100 psi and closed the fire doors to approximately one-half their original setting, it was possible to raise the CO_2 to 16 per cent at which time the visible smoke commenced. I then made adjustments that brought the CO_2 to 18 per cent, to learn the possibilities. Smoke became quite dense at this point. After these experiments we operated with a CO_2 content of 14 per cent which did not seem too severe on the refractory materials.

Some industries such as furniture factories have a supply of refuse but not enough to supply the power demands and this must be supplemented with coal. One such installation of which I had charge involved a plant equipped with 410 hp Oil City water tube boilers, set with small Dutch ovens with inclined front feed, overfeed stokers. The refuse was fed through the top of the oven on top of and in the center of the coal fire. This is shown in Fig. 2 and marked "Old Design."

With this setup the wood refuse seemed to blanket the coal fire. Clinker formation was troublesome, and black smoke was prevalent most of the time, especially when operating above 80 per cent of rating. We changed this setting to that shown in Fig. 2 marked "As Changed," obtaining ⅛ more useful boiler heating surface and 130 cu ft more furnace volume. Much of the refuse which was supplied at quite a uniform rate burned in suspension and the balance on the dead plates. With this arrangement the wood ash does not interfere with the coal fire. Clinker formation diminished materially and visible smoke commenced at approximately 100 per cent of rating, and became quite dense at 115 per cent of rating.

I then installed three steam jet turbulators, one in each front corner about 8 in. above the grates and directed towards a point 3 ft above the dead plate diagonally across the fire box, and one in the center discharging straight in at the same angle. With these in operation visible smoke appeared at 115 per cent of rating and increased in density as the load increased.

We later rebuilt one setting identical to the one just described salvaging only the boiler, converting to the arrangement shown in Fig. 3. With this setting the refuse is fed to the furnace through the front wall approximately 8 ft above the grates, and a booster jet of air is installed in the refuse pipe to help move the refuse and also to assist in the diffusion process in the furnace. The spreader type stoker which is designed to burn the dust in the coal in suspension and the larger particles on the grates, produces ideal conditions for the ignition of the refuse which is composed of fine dust, sawdust, and planer shavings principally, all dry.

The refuse burns almost in suspension. The three fly-ash ejectors discharging from the rear compartment through the bridgewall into the fire-box, together with the three turbulators installed in the front wall, one in each corner 3 ft above the grates and directed diagonally across the fire-box towards a point 16 in. above the grates, and one in the center directed straight in, at the same angle, produce turbulence which is very thorough. The air for the turbulators is taken from the passages around the steel supporting the front wall for the purpose of cooling.

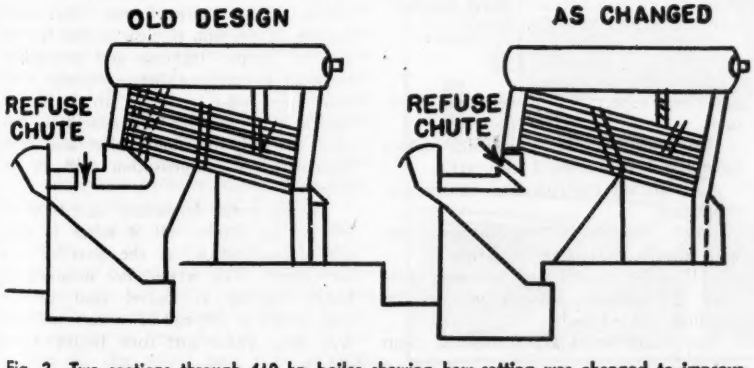


Fig. 2. Two sections through 410 hp boiler showing how setting was changed to improve combustion

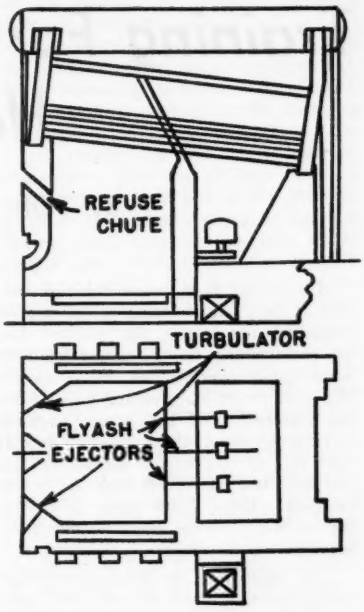


Fig. 3. Another furnace arrangement using the same boiler shown in Fig. 2 but with a completely new furnace

With the original setting, clinker was troublesome and visible smoke was prevalent most of the time, with the load at 80 per cent of rating or over. The setting as shown in Fig. 3, with the controls and adjustments in proper order, we carried up to 175 per cent of rating with no troublesome clinkers and aside from periods when dusting tubes or cleaning fires it is difficult to ascertain from the appearance of the stack whether or not the plant is in operation.

Conclusion

The function of a furnace for power purposes is to mix the fuel with the air under high temperature conditions and in the proper proportions, thereby liberating the heat therein and making it available so that the boiler can perform its function.

It is difficult if at all possible with manual control to obtain these conditions through any prolonged length of time as the load will vary requiring more air and fuel as the load increases and vice versa.

A matter of prime importance when considering the erection of a new boiler setting or the improvement of an old one to burn wood refuse is the fact that with a positive mechanical arrangement to deliver the fuel and air to the setting in the proper quantity and ratio, together with the proper facilities for mixing the fuel and air in the furnace and positive automatic control of all functions, a high level of success may rightfully be expected.

Training For Power House Foreman

By TOM H. JONES

THERE has been considerable discussion in these pages during recent months regarding the status, the welfare and the shortcomings of the power engineer —the plant operator as he is called. While it might be pleasant to consider the betterment of the power engineer in view of some of those the draft boards have left us to continue operations, this article is not concerned with the power engineer. Here, I am going to confine my remarks to the power plant foreman.

To begin with, the title, power engineer covers a multitude of sins, anything from a low grade janitor to skilled mechanics and technicians. How such men are treated, what they earn, how they are trained, therefore, depends upon the calibre of the engineer in charge and the organization he has developed for the smooth and efficient operation of the plant.

Taking the average industrial power plant into consideration, the power plant foreman or so-called chief engineer has charge of the power house gang, electrical gang and pipe fitting shop. The tin fitters seem to be a fussy class and generally stay to themselves. Now, to do all this and do it right calls for a fairly capable fellow but before we get generous let's take a look at two plants and then decide whether we are holding at $1500 or going up to $3600. The decision being up to the reader.

Plant No. 1

Bad organization.

Water treatment.

Combustion controls not functioning properly.

Powerhouse crew does a lot of hot foot business, etc.

Air compressors are over lubricated resulting in dirty air.

Powerhouse crew insufficiently trained in meeting emergencies.

Sloppy piping and make-shift feedwater treating system.

Considerable trouble with grounds in electrical system.

Temporary wiring considered as permanent.

Firing floor covered with grease and coal dust.

Ash handling system scatters dust all over property.

Insufficient maintenance program on all equipment.

High stoker maintenance despite normal boiler load.

Other items too numerous and petty to mention.

As much as the writer dislikes to admit it, there are too great a number of these power plants in existence and the blame lies both in management and the powerhouse foreman.

Management, especially among the individual plants and smaller corporations, have for too long a time considered the powerhouse a necessary evil. This, no doubt, is due to ignorance and lack of interest.

Though the war has emphasized the importance of the power plant, little could be done to improve conditions during the emergency period and many plants have been producing power by sheer good luck. As the war comes to an end and production begins to drop off, the chances are that things will continue in the same bad way with all thought and effort directed toward the processing end of the business. This, despite the need for conservation of our natural resources.

It is up to the powerhouse foreman to bring the problem of more efficient steam and electrical power production to the management. If he does not possess the ability to present a clear cut story to the management and be man enough to back it up, the common sense viewpoint would be for him to get out and give up the job as a complete failure. No management will turn down a program to save dollars and cents.

Considering plant No. 1, the power plant foreman is incapable, and may be holding his job as a consequence of the manpower shortage. If so, the day of reckoning will not be far off. There are too many boys coming back from the armed services with plenty "on the ball" after being trained in special branches and they will be looking for a chance to make use of their various skills. You can bet that most managements will give them a chance.

Plant No. 2

Good organization.

High respect for powerhouse foreman.

Feedwater control excellent, boilers have not been turbined in years.

Combustion controls are functioning properly.

Well disciplined powerhouse crew with excellent training program.

All shifts capable of meeting ordinary emergencies without getting the old man out of bed.

Air compressors are furnishing clean dry air.

Good piping and excellent chemical feedwater treating system, designed and fabricated in plant machine shop by the powerhouse foreman.

All wiring permanent and according to code.

Firing floor clean and a pleasure to see.

Ash handling system tight and efficient.

Low stoker maintenance despite high boiler load.

Good inspection and maintenance program covering all equipment.

The writer knows both powerhouse foremen personally and each receives the same compensation with practically the same type of plant in relation to steam and electrical power generating equipment.

Both have high school education and have been in the game for a number of years coming up from the firing line. Why one is superior is easy to note.

Powerhouse foreman No. 1 came by the job through seniority and has elected to hold on learning the hard way with the aid of a few power hand books only referred to in emergency.

Powerhouse foreman No. 2 also came by the job through seniority starting from the firing line but has been preparing himself along the way. First with Joe Hays' Course and then realizing his limitations slugged away through five years of night school in mechanical engineering. He keeps himself abreast of all new developments and if he does not understand a thing, he will keep at it until the answer is found.

One cannot help appreciating a fellow of this type and the management does also. If he wants anything he can present a clear cut story to the management and I can tell you now he is on the way to being a plant engineer.

This analysis may go hard on some of you boys but just take your hair down one of these days and examine yourself to see where you stand.

Organization Not the Answer

The writer is not endeavoring to get into a controversy with our friend Mr. Knapp[1] as there is a great deal of good common sense in what he has to say. However the betterment of the powerhouse foreman will not be found in complete national organization despite my full belief in capably managed unions. The powerhouse foreman's trouble at present is clearly due to the lack of proper training and education. In order to improve their economic position they must conform to a higher standard of training and education and then there is no doubt that the high standards of compensation will be in order.

In this great democracy an education is easy to obtain; all it takes is guts and determination on the part of the individual. The writer, not meaning to boast, started to shovel coal in the coal mines at the age of sixteen and for five long years got four hours' sleep

[1]See Men of Mechanical Might, By H. A. Knapp, March, 1944 issue.

per day while attending school, the scholarships being a gift of the Gods. Where there is a will there is a way.

The powerhouse foreman is a specialist and his duties cover much ground; therefore, he has to have a good basic knowledge in the field of mechanical and chemical engineering in relation to power generation. This, in the average sized plant, does not require a college degree or anything like it. The courses in power plant practice given by the various university night schools or correspondence schools are sufficient when combined with practical everyday operating experience, while working one's self up the ladder. The period of learning, however, is never completed, if one is to keep up with the advances which are continually being made in the power generating field.

To any young man who desires to become a good powerhouse foreman, or any management desiring to train their powerhouse personnel, the following program is listed for what it is worth.

Regardless of whether the fundamental education consists of a high school or a college degree, the good practical experience has to be obtained. The high school man will have to supplement his education through night school along the way.

One year in plant machine shop.
Six months with pipe shop.
Six months with electrical gang.
Two years firing, etc.
One year in charge of chemical feedwater treatment.

This should be the minimum amount of training before taking charge of a plant.

Now, a few reflections in passing which may make your hair stand up and why the writer is so inclined to criticize.

Case Studies

Recently, my attention was called by the management to the increased use of salt in regenerating a zeolite softener. In questioning the powerhouse foreman he stated that the river had been down and required more frequent generations at that time of the year. In checking over the regenerating records the softener had never gone below 30,000 gal in previous years, now it was down to 12,000 gal. In checking the softener bed, it was found to be highly dissipated and half the zeolite missing. Careful questioning of the operators and the backwashing procedures showed no loss of zeolite through this operation. A look into the clear-well gave the answer with 40 cu ft of zeolite being removed the following Sunday. The question is, why was an outside engineer called in when the problem could have been solved by the powerhouse foreman?

In the same plant several tubes were lost due to oil in the boiler and everything was considered from sabotage up. The answer was found by an outside engineer. On the centrifugal feedwater pump the connection from the low stage of the pump to the water seal was missing. The casing connection was plugged, an Alemite fitting inserted in the water seal and grease applied twice a shift. If the powerhouse foreman had been familiar with the design of centrifugal pumps, this would not have happened.

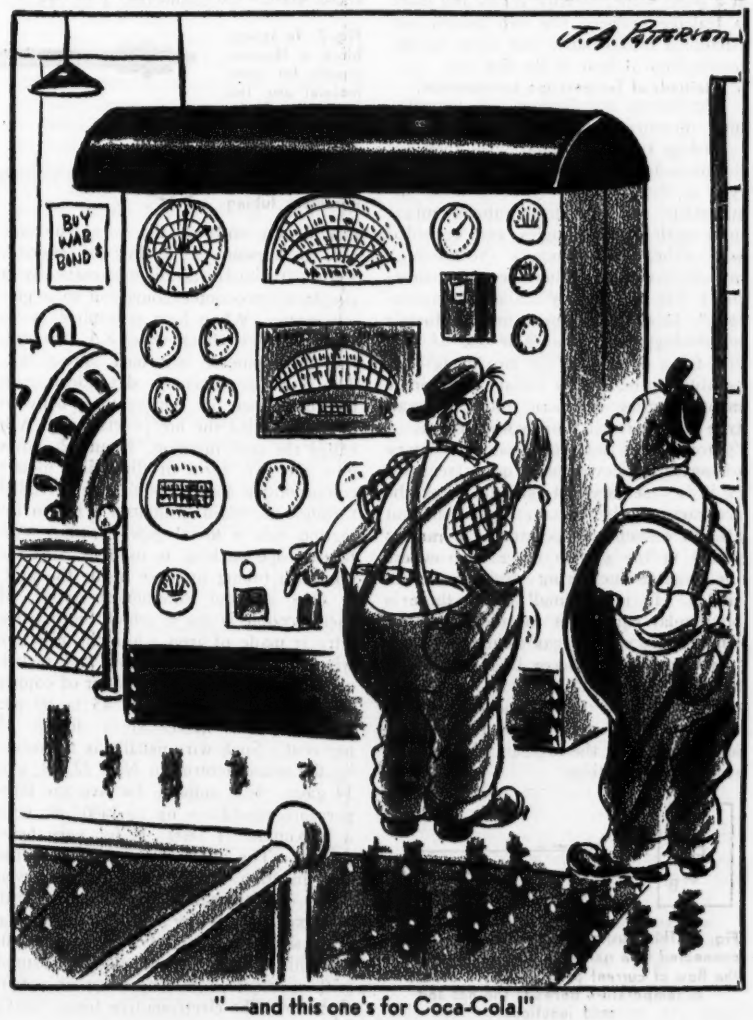
Again, in examining a boiler the superheater tubes showed evidence of carry-over. Checking over the boiler showed that the steam separator baffling had been installed wrong. Correct supervision and training of the operating crew by the powerhouse foreman would have prevented this.

Finally, when you come to a case of the following type, you really begin to wonder about the men that run some of our plants. At one plant the management was considering insuring a number of pressure vessels in the plant compressed air system. In taking the matter up with the local management the matter was turned down as their engineer stated that the interior of the vessels were well protected with oil and that he could see no danger of failure due to corrosion. Further inspection showed that the vessels were not automatically drained and held a dangerous amount of oil.

From these few instances it is easy to see that there is a dire need for a higher standard of education and training in the powerhouse operating engineers' field of endeavor.

The solution to the problem is a state or national license law governing powerhouse operating personnel. How this is to come about depends on the operating engineers themselves with their combined engineering and educational associations. However, I hope when it comes that it will not be the common question and answer variety as found in taking examinations in the cities having license laws. Any fellow can sit down for a few nights and memorize the answers. Before going any farther the writer offers his respect and admiration to those hard boiler examiners who stick to the rules and make sure the boys seeking an operating license know their stuff. However, this is not the general rule in a great many cases.

Let us all look at the situation for what it is worth. The powerhouse operating engineering field needs a strongly intensified educational and training program to obtain the respect and compensation due this specialized field of endeavor. It is up to the readers of the Practical Engineers' Section to start the ball rolling and keep it rolling.



"—and this one's for Coca-Cola!"

The Boiler Fireman's Handbook

By J. R. DARNELL

Effect of air leakage on furnace temperature . . . Methods of temperature measurement . . . Principle of the thermocouple . . . Materials used in the construction of thermocouples . . . Cold junction temperatures . . . The value of temperature readings in Boiler Operation

V. Measuring Flue Gas and Furnace Temperatures

In Chapter III the operator was warned to exercise extreme care in obtaining a representative sample of flue gas for analysis. The same care must be taken when measuring the temperature of that same sample. Leakage into the setting which reduces the true CO_2 value, also reduces the temperature. The reduction in temperature may or may not offset the lower CO_2 value when calculating heat losses. If, however, flue gas temperature is not measured at the same point where the sample is taken but is at a point some distance ahead and there is leakage between the two points, any attempted heat balance will show an excessive loss of heat in the flue gas.

Methods of Temperature Measurement

Permanent installations for temperature measurement usually are of the recording type. In some cases they are thermometers either of the resistance type or the gas-filled type; in other installations we find temperatures measured with thermocouples and recorded with either galvanometers (voltmeters) or potentiometers. Thermocouples sometimes are incorrectly called "pyrometers." In the instrument manufacturer's terminology a pyrometer is one of several types of devices for measuring temperatures produced by radiant heat. Some manufacturers designate either a wall type or portable millivoltmeter as a "pyrometer." But regardless of the type of measuring device used, quite frequently it is necessary not only to check the accuracy of the regular equipment but also to measure temperatures at various points in the system other than where the regular measuring devices are installed. In many small plants there is no regular equipment for measuring the temperature of flue gas even though the management may have been persuaded, away back when, to install a CO_2 recorder. It is here that a periodic check on temperature may be of great assistance in showing the fireman what kind of results he is getting.

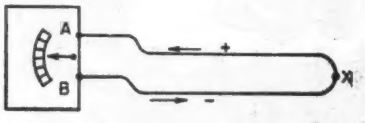


Fig. 1. This illustrates a simple thermocouple connected to a galvanometer which measures the flow of current produced by a difference in temperature between the hot and cold junctions

For ease and accuracy in obtaining check readings, the thermocouple is the best device obtainable, particularly when the electric current which it produces, is measured with a potentiometer. At this point a brief explanation of the principle of the thermocouple and potentiometer appears advisable.

In 1821, T. J. Seebeck, an investigator in electrical science, discovered that if two wires of dissimilar metals were joined and heat applied to this junction, an electric current would be induced in these wires. By connecting a galvanometer to the ends of the wires, he was able to measure this flow of current. Figure 1 illustrates diagrammatically a simple thermocouple connected to a galvanometer. When heat is applied at X, current flows along wire XA, through the galvanometer and back along BX. The flow of current is dependent upon the difference in temperature between point X, called the hot junction and AB, called the cold junction. Figure 2 shows how the two wires of dissimilar metals comprising a thermocouple are threaded through porcelain insulators prior to insertion into a metal pipe or tube. Asbestos rope packing is used to hold the porcelain tubing in place inside the pipe.

Fig. 2. In assembling a thermocouple for commercial use, the two wires of dissimilar metals are welded together and threaded through porcelain tubing

One of the commonest types of thermocouple is one in which the positive wire is made of iron while the negative wire is an alloy of copper and nickel, called constantan. The amount of copper in constantan varies from 45 to 60 per cent and the nickel from 40 to 55 per cent. Such wire usually is furnished by the manufacturer in Nos. 22, 18, and 14 gage. It is suitable for average temperature conditions up to 1400° F, with a maximum of 1800° F for very brief periods. The application of heat to the hot junction of a thermocouple even under conditions found in a furnace with low excess air — say 3000° F, produces a very small amount of electric current. But this current can be easily measured with a sensitive galvanometer or potentiometer. The electromotive force (emf) produced by thermocouples is measured in millivolts. A millivolt is 1/1000 of a volt.

When measuring the current produced by a thermocouple, if an ordinary galvanometer is used the resistance of the lead-in wires between the thermocouple and the galvanometer must be taken into consideration but when the potentiometer is used, the external resistance usually can be disregarded. Figure 3 shows a view of a portable type of potentiometer, the reading dial of which may be calibrated in millivolts or may be read directly in degrees Fahrenheit or Centigrade.

Manufacturers of thermocouple wire furnish their customers with tables or curves, such as Fig. 4, to indicate temperature-emf relationship for each kind and size of couple wire. Figure 4 is to be used for iron-constantan thermocouples. Besides iron-constantan wire, users of thermocouples may purchase chromel - alumel, copper - constantan, chromel-constantan and platinum-platinum and rhodium wire. The latter type of wire is very expensive and is necessary only for very high furnace temperatures. Between the serviceable range of iron-constantan wire and platinum, chromel-alumel wire has been found to be very satisfactory. The chromel wire which is positive is an alloy of 90 per cent nickel and 10 per cent chromium while the alumel or negative wire, is an alloy of 95 per cent nickel and about 5 per cent aluminum with small percentages of silicon and manganese.

The following table gives the normal and maximum temperature ranges recommended by manufacturers for various kinds of thermocouple wires. The maximum temperatures are those at which couples can be used for short periods:

	Degrees, F	
Type of Wire	Normal	Maximum
Pt.-Pt + Rh.	0-2650	3100
Cr.-Alumel	–300-2200	2450
Fe.-Const.	–300-1400	1800
Cu.-Const.	–300- 570	1100

As shown by the following table, the chromel-constantan couple produces the greatest emf for a given temperature difference while the platinum-platinum and rhodium couple shows the least:

Cold Jct. 32 deg.— Hot Jct. 500 deg. F

Type of Wire	Millivolts
Cr.-Const.	17.87
Fe.-Const.	14.09
Cu.-Const.	12.57
Cr.-Alumel	10.56
Pt.-Pt + Rh.	1.96

Fig. 3. This is a portable type of potentiometer used in laboratories and commercial plants for checking permanent thermocouples by taking test readings of temperature

We will not attempt to describe in detail the principle of the potentiometer except to point out that *basically* the unknown voltage of the thermocouple which is sent through a galvonometer, is made to balance with a known current provided by a combination of a standard cell and an ordinary dry cell. The amount of resistance necessary to effect this balance, i. e., the drop in potential across resistors built into the potentiometer, is read on the dial as millivolts or directly, as temperature.

The potentiometer has important advantages. As there is no current passing through the galvanometer-thermocouple circuit when a balance is obtained, the reading of the potentiometer is independent of the resistance of the circuit. Accuracy is not dependent upon the constancy of magnets, springs or jewel bearings and is *not dependent upon the* level *of the instrument.* It is an ideal instrument for all-around test purposes. When the dial is calibrated in millivolts any type of couple wire can be used, whereas if the scale is in degrees, only a definite type of wire can be used.

Where the fireman may wish to check his furnace temperature as well as flue gas temperature, he can use a thermocouple made of chromel-alumel wire or even the platinum combination if he has a potentiometer calibrated in millivolts and the proper emf-temperature table or curve. Number 14 gage chromel-alumel wire has been used for short periods for furnace temperatures up to 2800 deg F.

Jackets 20 ft long made of thin-walled tubing and provided with connections for water cooling have been successfully used for supporting thermocouple assemblies for reading high temperatures in furnaces. Space does not permit detailed description of this equipment but the author will be pleased to furnish instructions if readers are interested.

Furnace temperature readings may be of great value in checking the effect of incomplete air mixing or faulty air distribution. Such readings may also be used in determining the effect of arch design on the distribution of gases entering the tube bank.

In order to be certain of the average temperature of the flue gas passing through any given duct, a number of readings should be taken in the same plane. For example, if we assume a duct having inside measurements of 5 ft by 5 ft, four holes, one foot apart should be drilled in a horizontal line and four thermocouples, each at least five feet long should be inserted into each of the holes with the end of each couple one foot from the rear wall, as shown in Fig. 5. After taking readings with each couple as rapidly as possible, all couples should be pulled out for a distance of one foot and the readings again taken as quickly as possible. Such procedure should be followed until the ends of the thermocouples are one foot away from the outside wall. In this particular case the average of the sixteen readings — four for each couple — should be the average flue gas temperature.

Cold Junction Temperatures

In cases where thermocouples are inserted into a duct or setting wall as shown in Fig. 5, the cold junction is at the binding posts attached to the thermocouple heads and the temperature at these points must be determined and taken into consideration in arriving at the value for the hot junction temperature. If these couples are high up on the side of the boiler setting or breeching and it is not convenient to read a thermometer at such level, the cold junction can be brought down to the potentiometer which may be placed on a table or box at ground level. This is done by providing lead wires, from the thermocouples to the potentiometer, of the same material as the wires in the thermocouple. All potentiometers are provided with either manually operated or automatic cold junction compensators.

Instructions on the method of assembling thermocouples and in the use of potentiometers, galvanometers, or millivoltmeters can be found in the various catalogs of the leading manufacturers of such equipment. These are Leeds and Northrup Co., Wheelco Instrument Co., Brown Instrument Co. and Foxboro Co.

Firemen should make periodic checks on the condition of thermocouple wires at the hot junction. Excessive temperatures may oxidize the wires or there may be corrosive effects due to fuels with high sulphur contents. Thermocouples which are badly oxidized or corroded will be inaccurate. In some instances, oxidizing atmospheres have caused thermocouples to read high while reducing atmospheres and corrosive conditions cause low readings. In any event, the damaged wire should be cut off and a new weld made. If several inches of extra length of wire had been provided by wrapping several times around the binding posts, when the couple was first assembled, new wire can be obtained for the hot junction by loosening the wire at the binding posts and pulling out the length required to form a new hot junction.

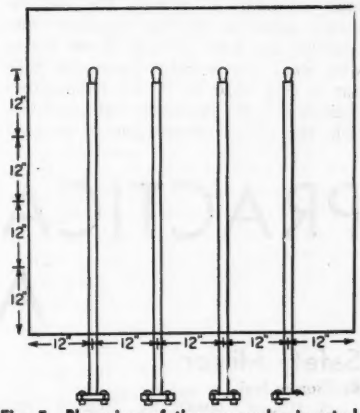


Fig. 5. Plan view of thermocouples inserted into a flue gas duct in order to determine the average temperature for a given cross sectional area

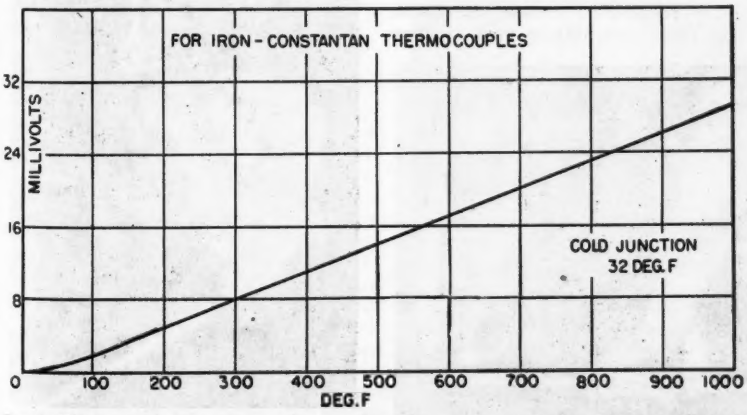


Fig. 4. This curve, for iron-constantan wire, shows the relationship between the emf induced in a thermocouple (result of temperature difference between hot and cold junctions) and the actual observed temperature at the hot junction

One investigator has found that the average life of iron-constantan couples, in use 24 hr per day, seven days per week is as follows:

Temp Deg F	Hours of Use
1700	672
300-800	8760

The above time does not indicate complete failure but if couples are kept

constantly at the temperatures indicated they should be renewed at the end of such time.

The Value of Temperature Readings

Any fireman who is interested in obtaining the best economy, although not necessarily the highest efficiency in boiler room operation should know the value of correct temperature readings. Temperature readings should be taken, not only of the exit gases but in the various passes through the boiler tubes. The flue gas temperature, at full normal load, immediately after soot has been blown should be taken as a standard. Any rise in temperature for the same load will indicate that the tubes are sooted or perhaps are accumulating scale on the inside. There also may be leaks in the baffles which might account for any abnormal rise in flue gas temperature.

In taking readings in the different passes, where it is necessary to insert a thermocouple between the tubes, care must be taken to prevent the thermocouple wires at the hot junction from touching the tube surface. Even if the wire does not actually touch the tube but is very close to it, the temperature indicated by the instrument will be lower than the actual temperature of the hot gas, because the tube surface is cooler than the gas. Whenever a thermocouple in inserted in hot gas surrounded by cooler surfaces, it absorbs heat by convection and its temperature rises. But, since the gas absorbs heat by radiation, as soon as the temperature of the thermocouple exceeds that of the surrounding cooler surfaces, heat is given up by the thermocouple to the cooler surface by radiation through the atmosphere of the enveloping gas. The temperature of the thermocouple may continue to rise for a time, but at a decreasing rate until the amount of heat which it gives off by radiation is equal to the amount received by convection. Equilibrium is then established but the actual temperature of the thermocouple is then lower than that of the gas.

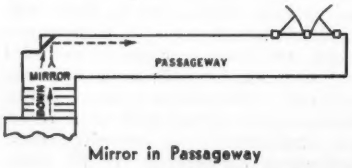
Due to the relative small area of the wire in a thermocouple with exposed hot junction as compared with one where this junction is shielded by a protecting metal tube or the comparatively large area of a commercial type thermometer, the thermocouple with exposed wire will give temperature readings of such accuracy that the radiation factor can be neglected unless, as previously stated, the wires at the hot junction are actually touching the tube surfaces.

PRACTICAL HINTS AND KINKS

Safety Mirror

By Thomas Trail

A MIRROR CORRECTLY located and fastened to the wall will provide a view around blind corners in narrow hallways and passageways where accidents are liable to occur due to collisions between employees carrying food, dishes, etc.



Mirror in Passageway

Dowel Pin Puller

TWO TYPES of dowel pin pullers suggested by workmen are used effectively at General Electric's Schenectady Works.

One, suggested by Francis Barton, has a knurled cylindrical sliding member which serves as a hammer. It slides along a shaft which is threaded at both ends. One end of the shaft is fitted with interchangeable heads threaded to fit various sized dowel pins. The other end of the shaft is fitted with a turned piece of machine steel which serves as an anvil against which the sliding member is pounded to remove the dowel. This device can also be used to drive dowel pins into place by reversing the action of the sliding member. This device is illustrated in Fig. 1.

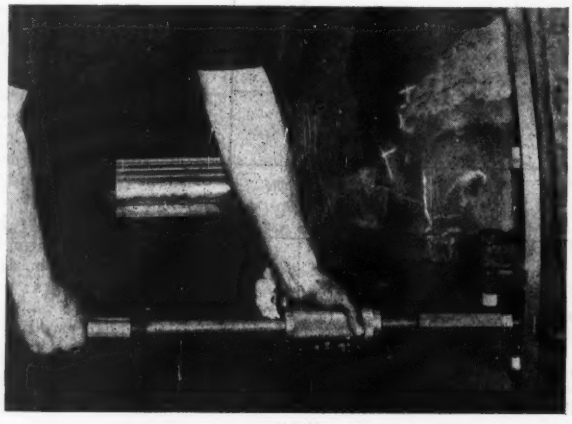


Fig. 1. Hammer type dowel pin puller

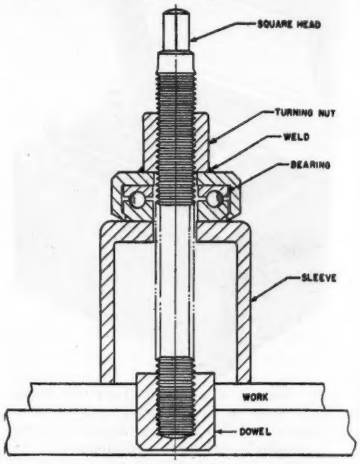


Fig. 2. Screw type dowel pin puller

The second dowel pin puller, shown in Fig. 2 suggested by Samuel Solini, employs a turning nut into which a ball bearing has been inserted. This eliminates friction between the turning nut and the sleeve, making it easy to exert a strong and steady force on the dowel pin, and reducing wear on the working parts.

Gasket Shaver, Made from Odds and Ends

A GASKET SHAVER, a device for splitting gaskets in one smooth continuous cut, is saving valuable production time at General Electric's Erie Works.

Originated by J. F. Downing, a test instructor at the Plant, the shaver is used to cut down to proper thickness the rubber gaskets used on a certain piece of equipment. These gaskets, although only an inch wide, are about 15

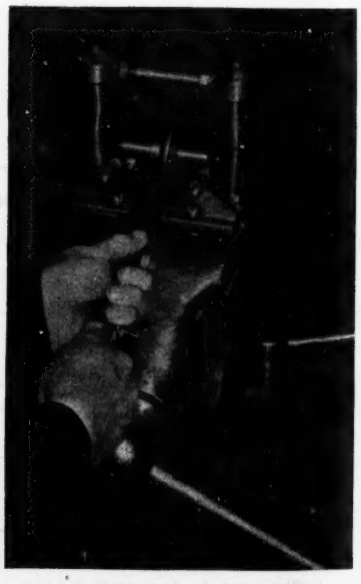


Fig. 1. View of gasket shaver in use at the Erie Works of the General Electric Co. It splits the gaskets in one cut

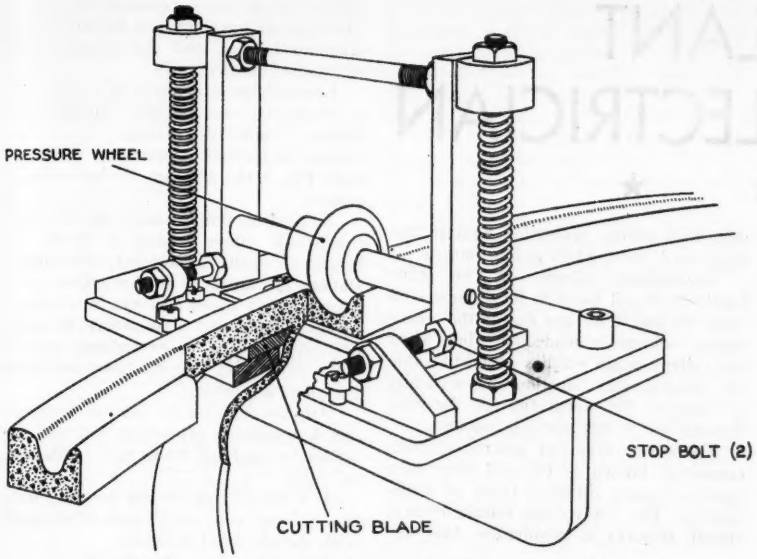


Fig. 2. Drawing showing the details of construction of the gasket shaver

ft in length. Grinding or filing the rubber strip not only consumed considerable time but resulted in an uneven surface.

The simple shaver which solved the problem was made from odds and ends found in the plant. The cutting blade is a broken file ground to razor sharpness. The pressure wheel is the only machined part used, being made to conform with the shape of the gasket. Adjustable nuts on either side of the shaver make possible cuts of varying thickness.

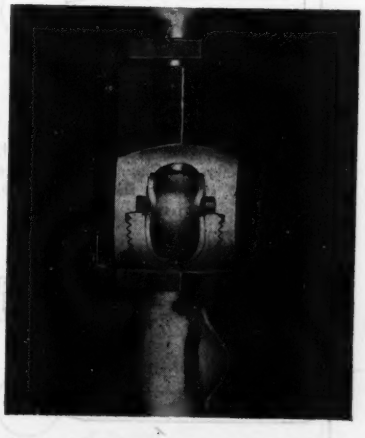
In operation, one end of the gasket is placed on the cutter, held in place with the pressure wheel, and pulled forward. The result is an evenly split gasket.

New Type Hydraulic Coupling

A NEW TYPE hydraulic tube connection which eliminates the tube flaring operation required with previous fittings, thus providing greater resistance to vibration breakage while simplifying installation procedures both in the shop and in the field, has been developed by The Glenn L. Martin Co., Baltimore, Md., and is being made generally available through licensed manufacturers. While designed to meet specific needs of the aircraft industry, the new fitting, which provides a firm, leakproof joint and can be used with both low and high pressures, is equally adaptable to the requirements of other types of hydraulics.

Invented by C. E. Holliday of the Martin Service Engineering Department, the new fitting is extremely simple in design and can be fabricated in large quantities at a minimum cost. Basic parts consist of the fitting, a gland nut, a small metal collar and a synthetic rubber sealing ring. The fitting is bored in four concentric diameters, corresponding respectively from the center out to the inside diameter of the tube, the outside diameter of the rubber ring and metal collar and the outside diameter of the gland nut, with the outside section threaded to take the gland nut.

To install the new fitting, one simply places the gland nut, metal collar and rubber ring over the end of the tube in that order and inserts the tube in the gland as far as it will go. By turning up the gland nut, force is exerted on the rubber ring with the metal serving to keep the nut from tearing the ring. Since the sealing ring is completely confined, and rubber is not compressible, the axial thrust so developed grips the tube and actually beads it. At the same time, the rubber is forced into every crevice to form a perfect seal and exerts an outward force on the gland nut, locking the threads. The beading operation is foolproof in that after the proper bead has been accomplished, the gland nut bottoms in the fittings and further crushing of the tube is impossible.



Connected with a new type Martin hydraulic fitting, this piece of ⅝ diameter by 0.049 in. wall aluminum tube burst under a 5000 psi pressure, but the fitting and joint were unaffected. Cut away portion shows the principle of the new fitting in which a rubber seal ring is compressed with such force by turning up the gland nut that it beads the tube and permanently seals the joint

By eliminating the flaring operation, the new Martin fitting removes one of the main causes of hydraulic line failure since this operation often affected the structure of the metal bringing about tube failure due to vibration in service. At the same time, it does away with the need for beveling the end of the gland nut, a relatively difficult machining operation, and permits the use of higher strength alloys than 52 SO where desirable.

From the standpoint of installation, the elimination of the flaring operation means an end to special preparation of the tubes, a time saver in the shop, and the difference between whether a repair can or cannot be effected in the field. With the new fitting all parts except the rubber ring may be used over and over again.

Still another advantage is provided in that with the new type connection, the fittings may be standard and have varying width compression rings for varying pressure requirements, thus reducing the number of separate replacement items which must be carried in stock.

Tests conducted in the Martin Laboratory have demonstrated the high pressure resistance and other characteristics of the new type fitting. On ⅝ in. diameter by 0.049 in. wall aluminum alloy tube installations pressures as high as 5000 psi in. have been successfully withstood, while on ⅜ by 0.035 in. tube the pressures have run up to 6200 psi. In both instances it was the tube itself rather than the fitting or joint which failed.

Laboratory tests have further revealed that pressure loss due to restriction is negligible due to the smooth contour of the restricted area.

Contact Pressure Adjustments

By A. J. Humphrey

ELECTRICAL devices which close without wiping and which depend on a pressure type contact for their normal current requirements are usually subject to overheating if their contact surfaces are not good mechanically. It has been found that an easy way to check a breaker or disconnect of this type is to insert a piece of carbon paper between the contacts and then close the switch slowly, preferably by hand. A sheet of paper may be inserted as well as the carbon paper to make a permanent trace of the contact pressure, or the carbon paper may be used alone, the pressure being judged by the gloss on the carbon paper surface. Only small pieces of carbon paper the size of the contact area need be used.

Excellent results have been obtained in finishing the contact surfaces of some large disconnect switches which depend on a large smooth contact area and heavy contact pressure. Very good adjustment of the contact fingers in circuit breakers is also possible.

FOR THE PLANT ELECTRICIAN

★ ★ ★

Know Your Pushbutton Circuits for Better Maintenance

By L. E. MARKLE,
Control Engineer,
Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa.

DEFINITION of terms used with pushbutton applications afford a foundation on which to build a few basic rules. Two terms that are sometimes confusing are low-voltage release and low-voltage protection.

Low-voltage protection allows all apparatus to be disconnected from the line if the power source fails or a disturbance occurs that causes the line voltage to drop to a very low value. In order to start the apparatus again, it is necessary to actuate the start button.

In order to obtain low-voltage protection, it is necessary to have a start button that closes the control circuit only when it is being held down. An electrical interlock that is closed when the control has functioned parallels the start button and keeps the control circuit closed after the start button is released. When the control drops out because of voltage failure, the interlock opens the control circuit, thus giving protection against unsupervised starts when power returns.

Low-voltage release, on the other hand, allows all parts to be disconnected from the line if for any reason the power source voltage is inadequate, but when the voltage again reaches sufficient value the control will function automatically to connect the apparatus to the line through the proper starting sequence.

These two types of control circuits, commonly known as two-and three-wire control, require different types of pushbuttons. The low-voltage release control circuit requires a pushbutton that remains closed until released by hand. This type of pushbutton is known as the maintained type, and the contacts are held closed mechanically.

Low-voltage protection is secured by a momentary-contact-type pushbutton. Figure 1 shows the diagram for a low-voltage-protection pushbutton connection; Fig. 2, the diagram for low-voltage release.

A control button does one of two things — it either makes a circuit or breaks a circuit. Heavy-duty pushbutton stations are arranged so that either operation or both operations can be obtained on the same unit. This ability to make or break circuits is exceedingly useful when more than just the start and stop functions are desired.

Any combination of control sequence for low-voltage protection can be obtained by applying these two fundamental rules:

1. Wire all stop buttons in series with the holding coil, with each other, and with the electrical interlock.

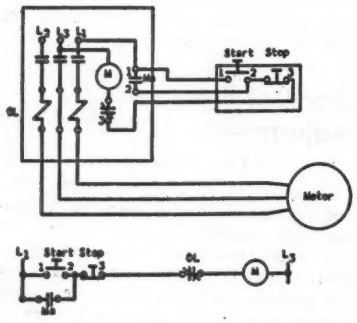


Fig. 1. Buttons: Two momentary-contact, one closed, one open. Circuit: Low-voltage protection, single station. Duty: Start-stop

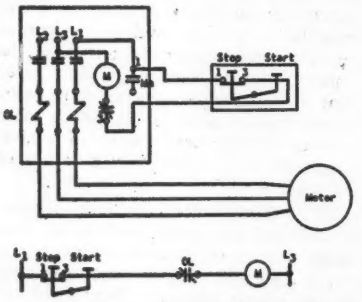


Fig. 2. Buttons: Two maintained-contact. Circuit: Low-voltage release, single station. Duty: Start-stop

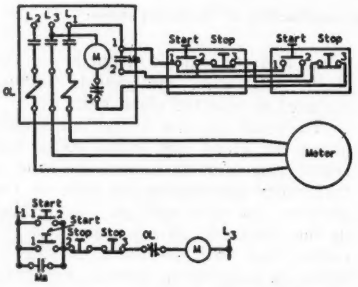


Fig. 3. Buttons: Four momentary-contact, two closed, two open. Circuit: Low-voltage protection, two stations. Duty: Start-stop, start-stop

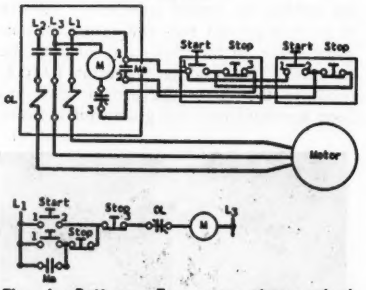


Fig. 4. Buttons: Four momentary-contact, two open, two closed. Circuit: Low-voltage protection, two stations. Duty: Start-stop, start-stop

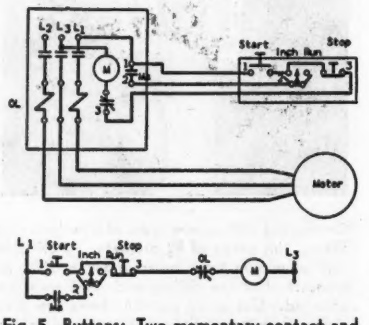


Fig. 5. Buttons: Two momentary-contact and one selector switch. Circuit: Low-voltage protection plus inching. Duty: Start-run, inch-stop

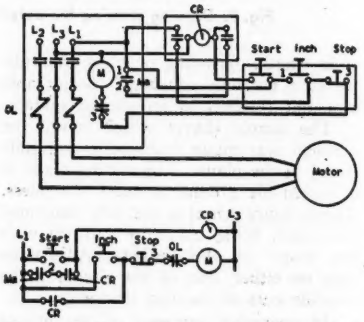


Fig. 6. Buttons: Three momentary-contact and inching relay. Circuit: Low-voltage protection plus inching. Duty: Start-inch-stop

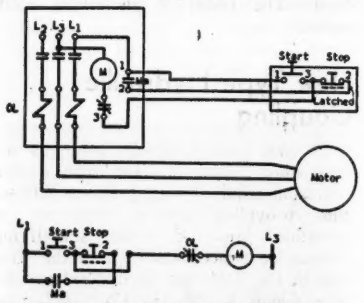


Fig. 7. Buttons: Two momentary-contact, one open, one closed with safety latch. Circuit: Low-voltage protection. Duty: Start-stop (on inch for latch)

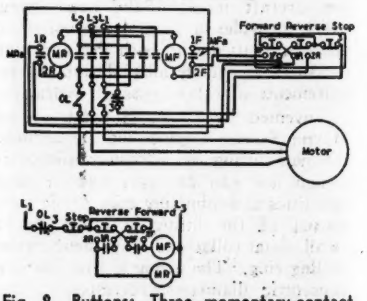


Fig. 8. Buttons: Three momentary-contact, two open, one closed. Circuit: Low-voltage protection, interlocked through pushbuttons. Duty: Forward-reverse-stop

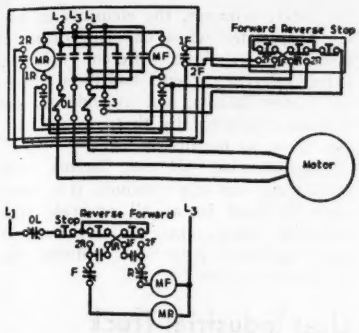


Fig. 9. Buttons: Three momentary-contact, two open, one closed. Circuit: Low-voltage protection interlocked through pushbuttons. Duty: Forward-reverse-stop

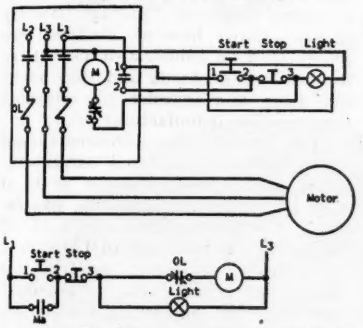


Fig. 10. Buttons: Two momentary-contact, one indicating light. Circuit: Low-voltage protection. Duty: Start-stop

2. Wire all start buttons in parallel with each other and with the electrical interlock.

Limit switches have not been included in any of the diagrams, although they are frequently used. These switches are governed by the same rules that apply to pushbuttons — that is, in most instances the pushbuttons can be replaced by a limit switch. Switches normally closed are similar to stop buttons, and those normally open operate as start buttons.

In the accompanying diagrams number 1 has been used to designate the control circuit to the start button; 2, the point common to the start-stop button; and 3, the stop button. On some controls manufactured currently these same markings are used to aid in making common pushbutton connections. The holding interlock parallels the start button; therefore, in the schematic diagrams it is connected to points 1 and 2 of the pushbuttons.

Simple Method of Checking P. F. Meters

IN LINE with periodic checking of instruments, power factor instruments are often neglected by reason of lack of equipment. A simple method of checking electrodynamic type power factor meters without the use of electrical standards and without the removal of the instrument from the board is as follows:

1. By removing lead A from the instrument, and shorting terminals A & B, the instrument should read 50 per cent lag or lead.

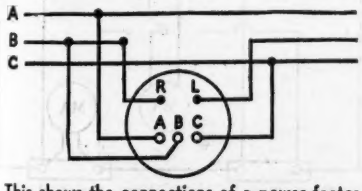
2. Next connect a jumper lead from A to C of the instrument. With this connection, the instrument should read unity or 100 per cent power factor.

3. With jumper removed, reconnect lead A to A of the instrument, disconnect lead from C and short circuit terminals B and C at the instrument. With this connection, the instrument should read 50 per cent lag or lead.

If these three points check, it can reasonably be assumed that all other points are in calibration.

Slight calibration adjustments may be made by changing balance as this is frequently the reason for calibration changes.

It must be remembered that power factor meters are of the ratio type which operate by the ratio of the forces of opposed coils. Such instruments have no control springs and, when in balance with no coils connected to circuits, the pointer will have no definite position on the scale. In other words, it should remain at rest in any scale position.



This shows the connections of a power factor meter to a supply line. With these meter connections, the meter will read the power factor of the line

Radio Noise from Fluorescent Lamps

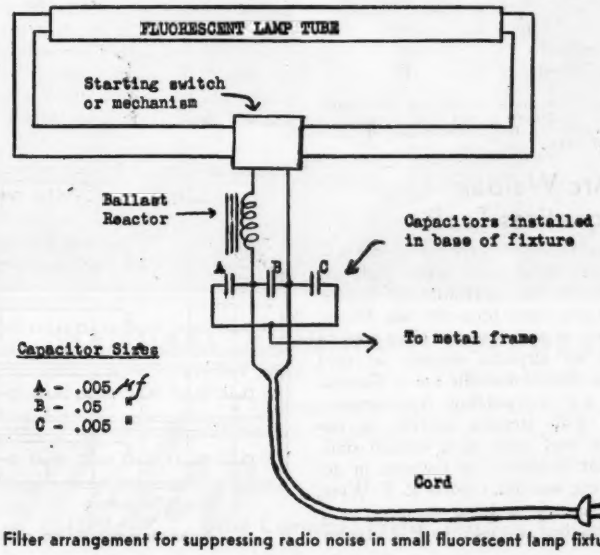
THE INTRODUCTION of fluorescent lamps has brought with it the problem of radio noise which is produced by the rapid interruption of the a-c arc within the tube. This characteristic is inherent in this form of illumination, although the magnitude of the radio interference produced will vary with different types of lamps and ratings. Where factories using fluorescent lighting are located well away from residential areas where radio receivers are used the interference usually does not constitute much of a problem but where small factories or plants are situated close to residences, the question of radio noise assumes considerable importance and it is necessary to take steps to suppress it.

Methods of suppressing interference from fluorescent lamps were given by C. S. Young of the Pennsylvania Power & Light Co., in a recent issue of the Edison Electric Institute Bulletin. These suggestions will be of value to any engineer confronted with a problem of this kind.

The extent to which fluorescent lamps disturb radio reception is dependent upon a number of factors, among which are the strength of the desired signal and the type of receiver antenna. The strength of the signal depends upon the transmitter power of the station being received and the distance between the station transmitter and receiver. Obviously, the stronger the station signal, the less objectionable a given radio noise becomes.

Radio disturbances from fluorescent lamps reach radio receivers by (1) direct radiation, (2) by radiation from connecting supply lines, and (3) by conduction along supply lines. Unless the conventional radio receiver antenna or lead-in is located within a few feet of the lamp, direct radiation is not serious, although radio receivers using internal loops may require greater separation from the lamp fixture. Usually the radiation from and conduction along supply lines are the most important factors. In order to minimize the effects produced by these forms of radio noise propagation, filters must be installed at the lamp terminals.

Some manufacturers incorporate a small capacitor in the starting mechanism of their units. When properly located in the circuit, this capacitor reduces radio noise to some extent. In a great many instances, however, additional measures must be taken to suppress radio noise. Filters are available commercially for this purpose, one type being termed a "Capacitive type filter," which is the



Filter arrangement for suppressing radio noise in small fluorescent lamp fixtures

simplest and most inexpensive type. There are cases, however, where this type of filter does not give sufficient reduction in radio noise, so that a combined capacitive and inductive filter must be used to attain the maximum degree of suppression.

In general, it will be necessary to filter each lamp or group of lamps in one fixture, since it is essential that the filter be located directly at the fixture terminals. In making a filter installation, it will be noted that one terminal or lead is to be connected to ground. Ground in this case means primarily the metal frame of the lamp fixture and not a water pipe or other actual ground.

In the case of small table or desk type lamps, there may not be sufficient room in the base to install a commercial filter. In such cases small short path tubular capacitors, installed in the base in accordance with the diagram shown in Fig. 1, will usually provide ample suppression.* Capacitors suitable for this purpose are readily available at radio parts stores. The capacitor should be of reliable manufacture and have a 600 v d-c continuous rating.

In Tables 1 and 2 some test data are given, showing the reduction in radio noise for a 15-watt desk type lamp, with and without a filter. Direct radiation with variation in distance from the lamp and radio noise fed into the supply line are indicated.

* Where the lamp fixture is ungrounded and within reach the capacitance from line to fixture should not exceed .007 μf.

TABLE 1

Direct Radiation at 1000 kc

Distance in Ft between Antenna and lamp	*Radio Noise Microvolts per Meter*	
	Unfiltered	*Filtered*
1	2,000	85
2	800	30
3	400	14
4	200	—
5	100	—
6	40	—
7	20	—

TABLE 2

†*Microvolts of Noise on Supply Line at 1000 kc*

Unfiltered	390
Filtered	19

† Measured in accordance with EEI Publication C9. A report of the Joint Coordination Committee on Radio Reception of EEI, NEMA and RMA.

A-C Arc Welder Demagnetizes Tools

INGENUITY HAS often led to the use of G-E arc welders to solve problems other than in the fabrication of metals. Among these have been the use of d-c equipments in thawing out pipes and in warming up airplane engines on cold mornings. Now comes the use of General Electric a-c arc-welding transformers, equipped with stepless control, to demagnetize steel parts by a method similar to that employed by jewelers in demagnetizing watches, reports R. F. Wyer, General Electric welding engineer.

This method was used by E. L. Bailey, electrical engineer at the Chrysler tank plant in Detroit, to remedy trouble caused by metal parts clinging to dies which had become magnetized. Five or six turns of cable were wrapped around the die and a heavy 60-cycle alternating current from a G-E 500 amp a-c welder was passed through the cable, the current then being gradually decreased by turning the current-control crank on the welder. This procedure is now regularly employed in the Chrysler plant.

Three-phase Power Measurement

By C. O. von Dannenberg

THE USUAL conventional methods of 3-phase measurement with the applicable formulas are as follows:

1. Using one 2-element meter or two 1-element, single phase meters.

Total W is $E_1I_1 \cos (30 - \theta_1) + E_3I_3 \cos (30 + \theta_2)$ in which E_1 and E_2 are line-to-line potentials.

2. Using one 2-element split-coil (one potential and two current coils) or two 1-element split-coil meters.

Total W is $E_{10} [I_1 \cos \theta_1 + I_2 \cos (60 - \theta_2)] + E_{30} [I_3 \cos \theta_3 + I_2 \cos (60 + \theta_2)]$

where E_{10} and E_{20} are line to neutral potentials.

3. For conditions known to be considerably unbalanced, method 2 should be replaced by one 3-element meter or three 1-element meters

Total W is $E_{10}I_1 \cos \theta_1 + E_{20} \cos \theta_2 + E_{30} \cos \theta_3$

This method is rigorous and gives a result absolutely correct without question; however, in usual practice the actual differences in the measurements when compared with method 2 are negligible and are well within the practical accuracy of the meters.

Reviewing the three methods it is at once clear that one single-phase meter reading would, when multiplied by a factor be merely a general indication of the total. For method 1 this would be truly only at 100 per cent power factor and a completely perfect 100 per cent balance of voltages and currents. The same comment applies to method 2. For method 3 the approximation might be closer, i.e., taking one single-phase reading and multiplying it by three to obtain the total; however, the elements of uncertainty enter when one considers the possibility of three different voltages, three different currents and three different power factors, and in addition, our reading multiplied by three would have the error so multiplied.

Summarizing all the factors concerned one can only conclude, if a measurement shall be at all accurate with assigned limits, some methods must be used including polyphase features, for its determination.

Uses Industrial-Truck Battery to Calibrate Shunts

THE ACCOMPANYING diagram which was presented by C. F. Holcomb in a recent issue of "Storage Battery Power" shows how an electrical engineer used an industrial-truck battery for calibrating shunts and thus saved the delay and expense of returning them to the manufacturer.

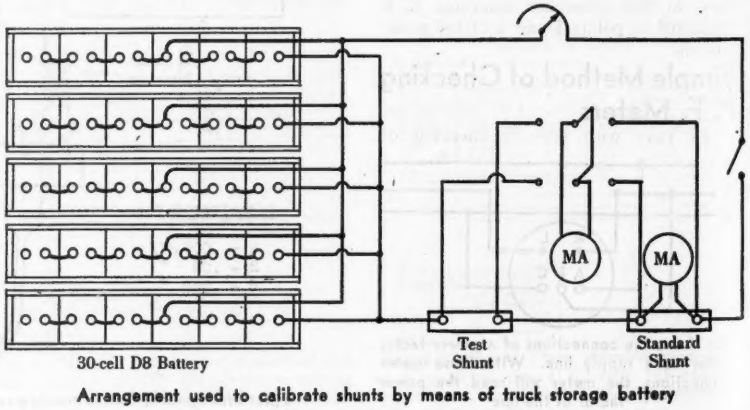
The shunts to be calibrated ranged up to 7500 amp in rated current capacity, and a steady current up to at least 10 per cent, or 750 amp, was desired. The battery used was a 30-cell D8 having a normal rate of 120 amp.

However, a 3-cell battery was judged to provide ample potential. Therefore, by considering the battery as being made up of ten banks of 3 cells each, and connecting them in parallel, it was possible to obtain the equivalent of a 3-cell battery having a normal rate up to as much as 1200 amp when all ten banks were parallel. Five banks are shown so connected in the diagram.

As a Kelvin Bridge was not available, a circuit was arranged so that the drop in potential across the test shunt could be compared with that across a standard shunt. As shown, this was done by connecting a millivoltmeter alternately across the two shunts.

No close regulation of the current was attempted; the series resistor was merely adjusted so as to result in a current not less than 10 per cent of the rated capacity of the test shunt.

A millivoltmeter was also connected across the standard shunt so as to indicate when the series resistor had reached its maximum temperature and the current was steady.



Arrangement used to calibrate shunts by means of truck storage battery

"here is a thought Joe . . . when wrestling with corrosion troubles"*

says *Ed. Fellows*

Nalco Representative, Houston, Texas

WELDING patches over corroded areas in water-jackets is a nasty job any way you look at it. Many plant engineers are ducking this task, Joe, by eliminating excessive corrosion with Nalco water treatment. There is no guess work in connection with the Nalco system . . . we just get down to brass tacks on *your own particular water treating problem* — with scientifically prepared chemicals, scientific research and a competent service staff.

Ask for a Nalco survey today . . . there is no obligation.

Photo in Nalco Laboratories

*Plant Engineer Joe says — "Excessive corrosion in our water jacketed heating tanks is another worry we have to wrestle with. These tanks are 6½ ft. in diam., 15 ft. long, and the heating water through the jacket is around 140° F. . . ."

Source: Survey conducted by a well-known power publication.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Ave., Toronto, Ontario

Nalco . . . The Complete Water Treating Service

LETTERS AND COMMENTS

He Was Fired for Saving Fuel

As AN INTERESTED READER of your Letters and Comments Department may I add some amusing experiences to it?

I have often heard it said that "nobody loves a fuel saver," not even the boss. Here are two actual examples of this.

A few years ago I was employed as an operating engineer by a large chemical company. The plant itself was not much as far as steam plants go, but it was a honey of a coal waster.

They had a row of steam-jacketed kettles without traps, and the steam at 60 psi used to whistle through them like a winter wind on its way back to the boiler room. The boiler room was constantly in a fog, in fact, I suggested to the manager that he install fog horns, because his plant was certainly heading for the rocks.

Now, the manager was a good scout but he did not know the first elements of steam engineering, nor would he believe me when I told him he was losing a lot of money in the operation of the plant. True, he did listen rather cordially to my suggestion that traps be installed, but he could not see why they should have them when the plant had operated for 20 yr without them.

The day came when they had to make some rather expensive changes in the plant and a consulting engineer was called in. The manager thought this would be a good time to check up on my engineering knowledge, so he asked the consultant about the traps. As I expected, the consulting engineer told him in practically the same words (he told me later) as I had, that he was losing a lot of money and ruining his steam plant at the same time.

The traps were installed, the fog disappeared, and the fuel bills cut down about 80 per cent. The company was so grateful that my pay was cut and I had to leave. This was a saving (to the company) that I could not endorse.

My next experience was in a large copper and brass company steam plant. This outfit had three boilers, all oil fired. It was evident to me that enough money had been lost in the operation of this plant to allow anyone to visit the fifty-dollar combination window of any race track quite often, no matter what kind of a pony picker he might be. This outfit was really running on a fuel-free basis. The amusing part of it is, the company kept a daily steam plant check which was supposed to show them where they were going. Everything looked "hunky-dory" on paper, but you can put anything on paper.

While employed with the company I enrolled for a course in combustion engineering specializing in oil burning. (Some guys will never learn.) Applying what I had learned in my studies to my work, I was able to increase the efficiency of two of their boilers from a lousy 68 per cent to a fairly respectable 76 per cent.

This meant a saving of around $1000 per year, since the plant had a considerable fuel bill. Here again, the company took advantage of my saving suggestions and made me pay for them. They had an automatic increase system, which was automatic for everyone except me. I had to get my pay raises through the local union.

I didn't care so much about this; after all perhaps I should have let them waste their fuel, but here is the pay-off. After leaving their employ they contested my claim for unemployment compensation, and this is going absolutely too far.

In conclusion, let me state that if any power plant employee has any intentions of saving his employer's money he had better get ready for trouble, because I can assure him it is ready-wrapped, and waiting delivery.

Chicago, Ill. HARVEY J. KRUMIN

High Voltage d-c Generator

I HAVE read the letter in the October issue of POWER PLANT ENGINEERING by W. S., in regard to his proposed high voltage generator, but I still maintain that it cannot be done. I will try to point out a few of the many reasons.

From the diagram shown and the brief explanation given, it would seem that all of the field coils were of the same magnetic polarity. In such a case, where is the magnetic flux going to find a path to complete its circuit?

As the stator is built with no iron for the magnetic circuit, what lines of magnetic flux do find their way to the stator windings must pass through air, which is a very poor magnetic conductor. Therefore, an excessive field would be required, the magnetic leakage would be great and the generator voltage regulation would be poor.

It would be impossible to excite the fields with a pulsating direct-current, and have a square wave form because of the reactance of the field coils; and if a square wave form could be obtained, it would still come out as alternating-current.

This is because of the fact that when the magnetic field surrounding a conductor is increasing, a voltage will be induced in one direction, and when the field is decreasing a voltage is induced in the opposite direction.

This may be shown quite easily with a direct-current voltmeter, small transformer and battery. Connect the voltmeter across one winding and connect the battery to the other winding. When the battery is connected the voltmeter will move in one direction while the magnetic field is being built up, and when the battery circuit is broken the pointer moves in the opposite direction while the magnetic field is collapsing.

This is a case where the transformer is excited by a pulsating direct-current, yet an alternating voltage is induced in the secondary.

W. Cummington, Mass. FRED E. GOULD

Editor's Note. In W. S.'s original letter on page 104 of the June issue, he proposed to supply the field coils through electron tube rectifiers. He proposed to commutate the alternating current by the use of tubes so that the field current would be reversed at the instant the poles were passing through the neutral plane between the armature coils. In this way, even though the poles themselves reverse polarity, W. S. hoped to induce in the armature a unidirectional current. As Mr. Gould points out, however, when a magnetic field dies down, it induces a voltage in the opposite direction to that which was induced when the field was increasing and it is difficult to see how W. S. could avoid the production of an a-c voltage in the armature winding.

Excitement In Small Plants

I AGREE 100 per cent with Pvt. Wm. Green in his plea for small plant operators. He has something there. Don't anybody tell you that a small plant man can't get any excitement and gray hairs. I got plenty of both. I have been, and probably will always be, a small plant engineer. I am now 52 years old. I had my first class license 18 years before I finally made up my mind to get a chief ticket. Then I did it because certain people kept at me to do it. My plant has two 250 hp Keeler boilers, old enough to retire and then some. Both are fired by double retort side dump Jones stokers. The other one is an old Kroeschell from the Majestic Building, Detroit, fired by an electrically operated double ram Detroit stoker. Steam is anywhere between yes and no (90 to 125) depending on the fireman. We have two Frick Ammonia Compressors, double

Wartime Service has been *Tough* on valves.. but not too tough for LUNKENHEIMER *Built-in* quality

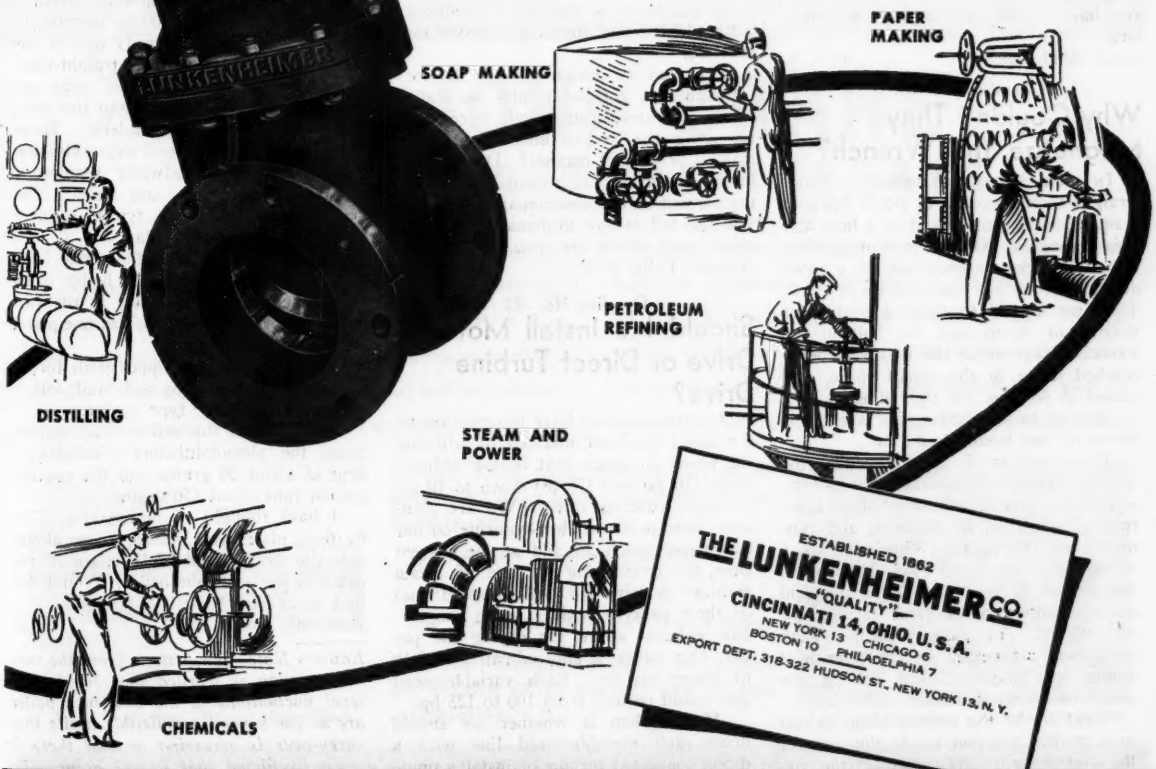
With production geared to tremendous volume, valves have taken a real beating during the war. It's been a gruelling test . . . of quality . . . of ability to *stay tight* under all service conditions.

In this severest of tests, Lunkenheimer Valves have proved their worth by giving consistent maximum service with a minimum of trouble and maintenance expense.

Simplicity of design and engineering "know how" are responsible for the exceptional record established by Lunkenheimer Valves on every wartime front—industrial and military.

In coming peacetime, as during the past three-quarters of a century, a solid assurance of top economy and performance lies in Lunkenheimer built-in *lasting* quality.

Lunkenheimer Distributors too have measured up to a tough assignment . . . to keep their vitally needed service channels open despite almost insurmountable handicaps. The facilities of this nationwide organization are at your service always.



BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

cylinder, U.S.A. Corliss operated, installed in 1916 and 1918 or thereabouts and a Frick 12 x 12 in. electric compressor. This is a meat packing plant.

The owners are of the type who grab all they can get and hate to let go of a cent and I don't mean Scotch either. We operate one motor generator set and no standby of any kind. When this goes on the Fritz we just shut down. We have one brine cooler, no spare. Same story. Three piles of junk that pass for air compressors. One poor old feedwater heater that handles enough water to float a battleship. The water is all new city water and all returns and jacket water go to sewer. City water used on all jackets. The float valve to the heater leaks. So instead of repairing it or replacing it, our overflow pours tons of water to the sewer everyday. I suggested collecting all returns and jacket water in an overhead tank and letting it be used up as feedwater, but was told it wouldn't work. You have in the past published plenty of my stuff and it was nearly all taken from this plant. The only reason I'm staying there is the money is "fair" and the work is easy, and I am waiting to see what will happen next. R. G. S.

Questions And Answers

Question No. 280

How Fill Cracks in Concrete Chimney?

WHAT is a good mixture with which to wash and close up cracks in a concrete chimney? Most of the cracks run vertically and they vary in size; some are hair cracks and some are much larger.

Great Bend, Kan. C. L. S.

Question No. 281

Why Couldn't They Magnetize the Wrench?

IN OUR SHOP we needed a long, straight socket wrench to reach down in a small space, place a bolt in a hole and then tighten it. One of our machinists turned a socket wrench out of a piece of high-carbon tool steel and hardened it. Then we wanted to make a permanent magnet of it, to hold the bolt in the wrench socket while the bolt was being reached down in this small space, and placed in position for tightening.

Trying to magnetize the wrench is where all our trouble came in.

First we tried to magnetize the wrench with an electromagnet constructed of a coil wound around a hollow brass tube about 1 in. in diameter, and connected to 110 v, a-c. This gave us a strong electromagnetic field. We passed the wrench in one end of the tube and out the other end without turning off the current. This gave us such a weak permanent magnetism in the wrench it would not hold the steel bolt in the socket of the wrench.

Next we let the wrench come to rest in a neutral position inside the core of the electromagnet and turned off the current before withdrawing the wrench. This gave us a little more permanent magnetism but still not enough to hold the bolt in the wrench.

Then we took the rotor out of a ¼-hp a-c motor, and tried to magnetize the wrench on the motor's field pole. This gave us a very strong magnetic pull when the wrench was against the field pole but when we took it away, the wrench was not magnetized any stronger than it was before.

We tried to get some information from an electrical engineer's handbook, but could not find anything to cover our problem.

How can we design and use an electromagnet to get the results we want? Some questions in our minds were: Are we using the proper kind of steel to make a permanent magnet? Do we have to use direct current instead of alternating current on our electromagnet? Could you also tell us how to demagnetize some other tools which are now magnetized?

Niagara Falls, N. Y. V. M. S.

Question No. 282

Should He Install Motor Drive or Direct Turbine Drive?

I WOULD LIKE to have information on the latest and best methods of utilizing the power in steam that is now reduced from 110 psi and 175 psi down to 10 psi through reducing valves. We are planning some post-war developments on our two paper machines and at the present time are considering the use of steam turbines to drive the variable-speed lines of these paper machines, using the turbine exhaust steam for drying the paper. Our output is approximately 1000 lb of paper per hr. Each variable-speed line would require from 100 to 125 hp.

My problem is whether we should drive each variable-speed line with a direct-connected turbine or install a single larger turbine to drive a generator supplying electric power to a variable-speed motor on each of the variable-speed lines? What is the best method of getting this power from the steam? Which of the two methods would be most efficient? Aside from the question of thermal efficiency, what would be the advantages and disadvantages of each method?

Massachusetts M. H.

Editor's Note — So much additional information would be needed to give a specific answer to these questions that we realize only the most general comments on the method of attacking the problem can be given. Nevertheless it would be valuable to learn the experiences and ideas of Q & A readers on these points.

It may help in commenting on them to know that M. H., in previous correspondence about other problems, has told us that an old engine and a low-pressure turbine, also a water wheel generator, are installed in his plant. In 1942, the plant generated 62 per cent of its required power by water power, 25 per cent by steam and purchased the remaining 13 per cent. In 1943, for some reason we do not know, the engine and turbine were not operated for long periods, power being purchased. This may have been done for reasons connected with pooling of power supply during the war or in connection with best utilization of fuel supply in that region.

Question No. 283

Why Is Water Level Hard To Control?

A YEAR AGO last summer we installed in our boiler plant one 300-hp four-drum, bent-tube boiler. We already had in operation two other 300-hp straight-tube, cross-drum boilers. All three units are operated together, connected to the same steam and feedwater headers. These three boilers are equipped with extension type thermostatic feedwater regulators, all of the same type and make. The load on these units is a typical canning factory load, very irregular.

I want to know why the water level in the four-drum, bent-tube boiler is so hard to control. The water in the two older cross-drum units stays in one place, for instance, two gages.

The new unit is equipped with forced and induced draft fans and fired with a pneumatic spreader type stoker.

I don't think the unit is foaming, because the phenolphthalein alkalinity is kept at about 20 grains and the concentration runs about 150 grains.

I have thought of taking two ¼-in. by 6-in. plates and placing them alongside the dry pipe the full length of the drum in the bent-tube boiler. Would this be a good idea?

Portland, Ind. G. B.

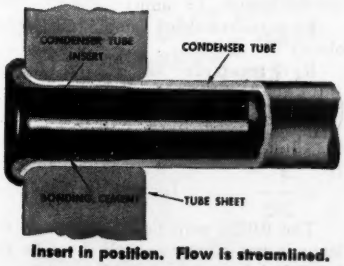
Editor's Note—We assume from the way the question is worded that the water-level fluctuations in the bent-tube boiler are so far beyond permissible limits that carry-over is occurring or that there is great likelihood that it will occur. We assume also that G. B. has checked with the manufacturer of the feedwater regulators to make sure that the regulator on the bent-tube boiler is correctly installed and adjusted.

Make CONDENSER TUBES *Last Longer!*

Install JOHN CRANE
CONDENSER TUBE INSERTS

Unprotected condenser tubes most often fail at the inlet end; the section most vulnerable to pitting and thinning. The John Crane Condenser Tube Insert *armors* the belled mouth and entrance section of the tube—*completely eliminates inlet end air erosion and sand abrasion;* helps to prevent outages.

These Inserts are molded of a *hard, wear-resistant* bakelite material, unaffected by temperatures to 275° F. and resistant to contaminated salt or fresh water. Installation is easy on old or new tubes: simply slip the Insert into place. Available for 5/8" and 3/4" 16 gauge, or 5/8", 3/4", 7/8" and 1" 18 gauge tubes.

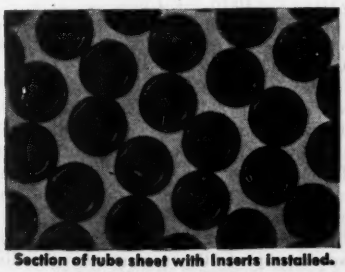


Insert in position. Flow is streamlined.

Service tests over a long period of time show that John Crane Condenser Tube Inserts

- **Greatly lengthen tube life**
- **Save critical metals**
- **Pay for themselves many times**

Send for illustrated bulletin, or consult our branch office nearest you for full information.



Section of tube sheet with Inserts installed.

CRANE PACKING COMPANY

1812 CUYLER AVE. • CHICAGO 13, ILL.

BALTIMORE, BOSTON, BUFFALO, CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

CRANE PACK'NG CO., LTD., Hamilton, Ontario, Canada. Branches: Montreal, Toronto, Vancouver

Answer No. 254

More About the Slamming Check Valve in the Compressor Discharge

Interest in the noisy air compressor check valve problem published in the March issue was tremendous. A flood of letters poured in, which we have not space to publish and they are still coming. Obviously many men have been annoyed by slamming check valves. Many of them agree on certain courses to follow to eliminate the trouble; a few are summarized below.

For instance, Arthur Yeates of San Francisco, Calif., points out that a pressure controller and diaphragm-actuated suction valves, similar to Dobson's idea in the June issue, is the best solution. He also says the discharge line could not unload between compressor and receiver, as now connected.

Wm. T. Estlick of Ansomia, Conn., agrees that the compressor valves should be carefully checked and advocates installing a horizontal lift check valve with a composition disc as better for this case.

Stanley H. Gilmore of Chicago recommends the installation of a Williams-Hager check valve as described below. Use of an automatic starting unloader and removal of the present check valve is advocated by Jesse L. Erisman, St. Louis, Mo., although he says a piston or spring-loaded check could be used. He questions the correctness of A. J. K.'s original hook-up diagram. Correct or not, that's the way A. J. K. submitted it to us.

Is A. J. K.'s control method the best? asks our old standby C. G. Clark of St. John, N. B. He says the best system is one that unloads by lifting the suction valves or closing a suction line valve automatically, letting the cylinder operate under vacuum at a little higher metal temperature. He says the present unloader could be adjusted for a slower pressure loss or the check valve replaced by one more suitable for this service.

William T. Mullen thinks the entire compressor hook-up as shown is unsatisfactory. He wouldn't use the check valve at all, but let the unloader control. (That's assuming the discharge valves are tight.—Ed.)

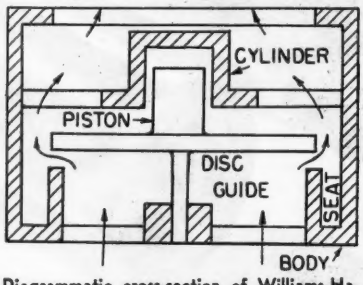
An idea for eliminating the check valve was suggested by M. S. Parkhill of Corning, N. Y.

Replace the present noisy check valve with a 2½-in. gate valve, he says. Between this gate valve and the compressor discharge connection put a cross. From one branch of the cross, lead a bypass line to atmosphere and put a gate valve in it. On the other branch of the cross place safety valve set to pop at 10 per cent over the discharge pressure.

For starting, close the main valve and leave the atmospheric bypass valve open. Then close the bypass valve gradually and simultaneously open the main valve into the receiver. The safety valve on the cross will prevent excess pressure building up in case the bypass is closed too rapidly or main valve is not opened rapidly enough.

Editor's Note—Since a number of readers have specifically mentioned the installation of a silent check valve in this air compressor discharge line to replace the present check valve, we show here a diagrammatic cross-section of the Williams-Hager valve as made by The Williams Gauge Co. of Pittsburgh, Pa.

It consists of body, seat and disc, the body equipped with a cylinder and the disc with a piston, the bottom of the disc having a guide. Installed in an air compressor discharge, the disc rises when the compressor cuts in, raises the piston, which forces air out of the cylinder. This creates suction on the piston head, holds the check valve open without pulsation. When



Diagrammatic cross-section of Williams-Hager compressed air check valve

the compressor cuts out, the weight of the disc releases the suction and the disc seats.

A recent test showed an air compressor operating at 100 psi, 100 rpm at intervals of 4 minutes, 24 hr a day, was completely silent and after 30 days operation the machine tool marks were not worn from the contact surfaces of seat and disc, according to the manufacturer.

Answer No. 268

Why Does Heater Heat When Light Won't Light?

THE ANSWERS to this question, asked by J. D. T. in the August issue, still roll in. He has a heating element R connected in a 110-v circuit supplied by a generator. The entire heater heats up. When a test lamp is connected from one end of the heater element to ground, the lamp lights up. When connected from the other end of the heater element to ground, the lamp does not light up. Why is this thus, when the entire heating element is hot, proving that there's current at both ends of it? A number of answers appeared in the November issue; here are others.

Look in the Branch Circuits

THE ANSWER can be found in the branch circuit department. In any branch circuit network where the potential drop is identical, the branch currents are inversely proportional to the two branch resistances of

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$

To make the explanation of this statement easier to understand, we shall assign numerical values to J. D. T.'s appliances, the test lamp and the heater resistance, as shown in the sketch.

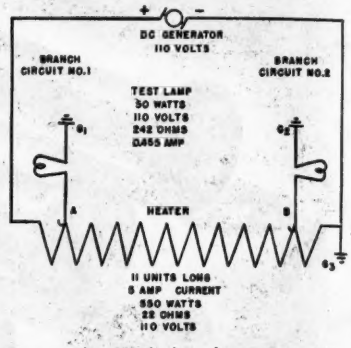


Diagram by Heidecker showing conditions in J. D. T.'s circuit with actual values

Let us say J. D. T. hooked his test lamp on the heater at point A. This is branch circuit No. 1, and part of the current flows through the lamp branch to G_1, and the rest through the heater branch to G_3.

Let

I_1 = current flowing through the lamp branch

I_2 = current flowing through the heater branch (5 amp)

R_1 = resistance of the lamp branch (242 ohms)

R_2 = resistance of the heater branch $\left(\frac{10}{11} \text{ of } 22 = 20 \text{ ohms}\right)$

Substituting numbers in the formula

$$\frac{I_1}{5} = \frac{20}{242} \qquad I_1 = 0.414 \text{ amp}$$

The 0.414 amp flowing through the lamp is strong enough to make the lamp light.

Let us consider branch circuit No. 2 and connect the lamp to the heater at point B so the current will flow from B through the lamp to G_2. The remainder of the current flows from B through the heater branch to G_3.

Let

I_1 = current flowing through the lamp branch

I_2 = current flowing through the heater branch (5 amp)

R_1 = resistance of lamp branch (242 ohms)

R_2 = resistance of heater branch $\left(\frac{1}{11} \text{ of } 22 = 2 \text{ ohms}\right)$

Substituting numbers in the formula

$$\frac{I_1}{5} = \frac{2}{242} \qquad I_1 = 0.0414 \text{ amp}$$

The 0.0414 amp flowing through the lamp is not strong enough to make the lamp light, as it takes about 0.2 amp with a pressure of 110 v to make the lamp glow red.

The 5 amp flowing through the heater branch is of sufficient strength to heat up the resistance.

If a voltmeter were connected at

Piping materials for any system ...CRANE supplies them all

ONE SOURCE OF SUPPLY...ONE RESPONSIBILITY FOR ALL MATERIALS

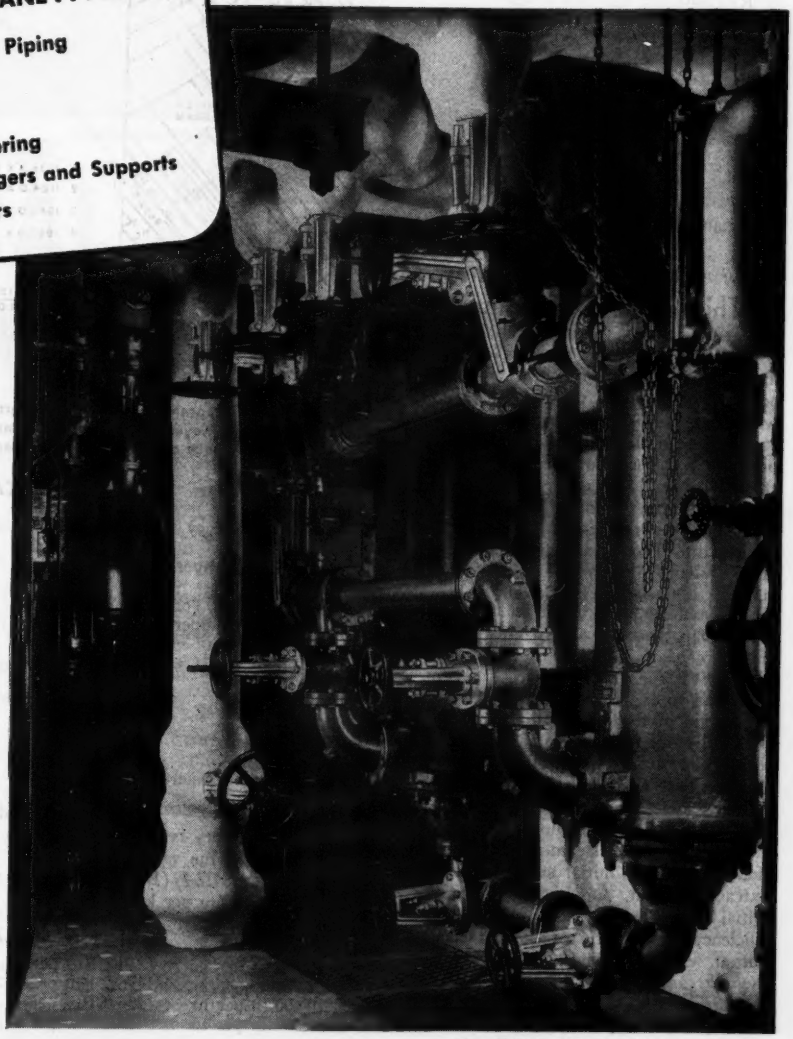
More helpful than ever, now that war deferred maintenance must be reckoned with, Crane *complete* piping materials service simplifies every step of piping rehabilitation. One reliable source—your Crane Branch or Wholesaler—supplies everything you need, be it a single fitting or a complete new system. In brass, iron and steel materials for all power and process piping applications, the Crane line provides the world's most comprehensive selections.

One order to Crane covers all your requirements for any job. One responsibility for the quality of all parts helps assure the best installation. But mainly, by always specifying Crane materials, you get full benefit of 89 years' experience and leadership in meeting industry's piping needs.

Crane Co., 836 S. Michigan Avenue, Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

PIPING EQUIPMENT BY CRANE...100%

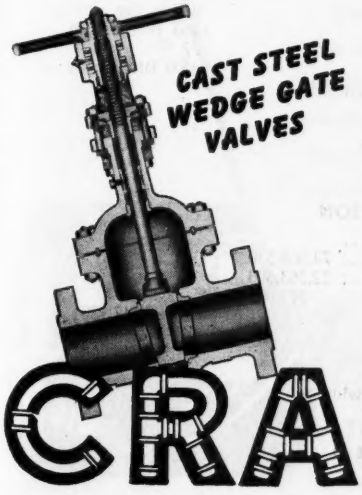
- Gate Valves
- Globe Valves
- Check Valves
- Screwed Fittings
- Flanged Fittings
- Pipe
- Fabricated Piping
- Unions
- Flanges
- Pipe Covering
- Pipe Hangers and Supports
- Separators



Installation in Industrial Power Plant

ONE STANDARD OF QUALITY

The same high quality protects every part of piping systems when Crane materials are used throughout. In Crane Steel Gate Valves, for example, straight-through ports permit unrestricted flow. Severest line stresses are overcome by sound and rugged body castings. Smooth operation is maintained by a ball joint type stuffing gland, strong tee-head disc-stem connection, and ample stem bearings. Positive seating is assured by extra long disc guide ribs.



CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

point B to ground, it would show about 10 v

and

volts (10) ÷ ohms (242) = amp (0.0414)

also

volts (10) ÷ ohms (2) = amp (5)

Chicago, Illinois WALTER HEIDECKER

Connection of 2 resistances in parallel is of frequent occurrence in electrical circuits; the properties of parallel circuits show that

$I = I_1 + I_2 \ldots$ and $V = V_1 = V_2$

whence $R = \frac{V}{I} = \frac{V}{I_1 + I_2}$

and therefore

$$\frac{1}{R} \quad \frac{I_1 + I_2}{V} = \frac{I_1}{V} + \frac{I_2}{V} = \frac{I_1}{V_1} + \frac{I_2}{V_2}$$

$$\text{or } \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{R_1 + R_2}{R_1 R_2}$$

from which the equivalent resistance is found to be

$$R = \frac{R_1 R_2}{R_1 + R_2}.$$

Since the potential drop is the same for either branch it follows that

$$I_1 R_1 = I_2 R_2$$

This explanation is found on pages 378-379 Physics, 1939 Edition; Erich Hausman—Edgar P. Slack.

Answer No. 266

How Calculate Efficiency of This 2500-kw Turbine?

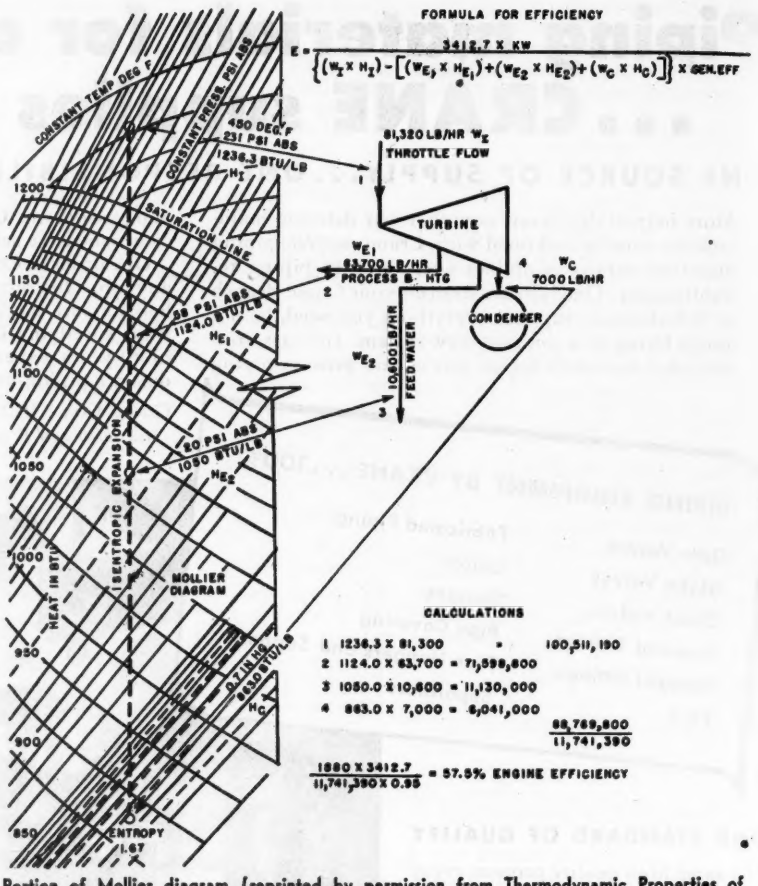
THIS QUESTION was asked in the July issue by R. B. M., who gave data on the measured flows, pressures and temperatures, as well as the manufacturer's water rate and extraction curves. Because of space limitations, these cannot be repeated here but if readers want them we shall be glad to send tear sheets. In the October 1944 issue we published the replies of Messrs. Heidecker and Fox and now here is one from Julian P. Calvert.

Calculations by Calvert

WE ARE ASKED to define and calculate the actual thermal, and overall engine efficiency of a 2500 kw extraction-condensing turbine from the accompanying data, and to explain the engine efficiency by the aid of the Mollier diagram.

The engine efficiency of an extraction turbine is defined as follows by the ASME Test Code For Steam Turbine. "The turbine is regarded as having a number of independent flows, as for example, from initial steam to first extraction point, from initial steam to second extraction point, and so on, and from initial steam to exhaust. The engine efficiency is the ratio of the net energy output, expressed in terms of heat, to the aggregate work available. The work available is the sum of the aggregate isentropic enthalpy drops of each of the flows from initial enthalpy to the enthalpies corresponding to the measured pressures at each extraction point, including the exhaust, calculated at the entropy of the initial steam, with allowance for glands, if necessary. This is shown on the accompanying diagram.

Flushing, N. Y. JULIAN P. CALVERT



Portion of Mollier diagram (reprinted by permission from Thermodynamic Properties of Steam, by Keenan & Keyes; John Wiley & Sons, Inc.) showing method of figuring engine efficiency of extraction turbine as given by Julian P. Calvert

DATA

1) Generator Load	1880 Kw
2) Generator Efficiency (given load)	95 per cent
3) Throttle Flow	81,300 lb per hr
Pressure & Temperature	231 psi abs, 450 F
Enthalpy	1236.3 Btu per lb
4) Extraction Flow (process & heating)	63,700 lb per hr
Pressure & Temperature	58 psi abs, 290 F
Enthalpy	1176.9 But per lb
5) Extraction Flow (feedwater heating)	*10,600 lb per hr
Pressure	20 psi abs
Enthalpy	863 Btu per lb
6) Exhaust Flow	*7,000 lb per hr
Back Pressure	0.7 in Hg
Enthalpy	863 Btu per lb
Condensate Temperature	77 F
Enthalpy	45.0 Btu per lb

*Estimated values

The thermal efficiency is the ratio of the heat equivalent of the work done to the heat supplied or 3412.7 (Btu per kwhr) to the heat rate (Btu per kwhr).

CALCULATION

81,300 lb per hr × 1236.3 Btu per lb.....		100,511,190
63,700 lb per hr × 1176.9 Btu per lb.....	74,968,530	
10,600 lb per hr × 1156.0 Btu per lb.....	12,263,600	
7,000 lb per hr × 45.0 Btu per lb.....	315,000	
		87,547,130
		12,964,060

$$\text{Heat rate } \frac{12{,}964{,}060}{1880 \times 0.95} = 6550.3 \text{ Btu per kwhr}$$

$$\text{Thermal efficiency } \frac{3412.7}{6550.3} = 52.1 \text{ per cent}$$

Here's a "GENERAL" ...WITH THE VICTORY HABIT!

Fuel-Saving Starts With CONTROL

JUST as certain leaders have a genius for training their men into efficient, hard-hitting, unbeatable fighting units, so Hays Combustion Control "gets the best" out of a steam power plant — makes it an efficient, smooth operating economical plant. Its automatic performance conserves man power.

Here, indeed, is a "general with the victory habit." Your Hays Combustion Control regulates every element of combustion, makes each one function at its best. It maintains a perfect balance — measures each variation, and corrects it instantly: all automatically.

Stretching steam capacity safely, getting top efficiency out of existing boiler room equipment, saving man-hours and fuel costs—Hays Combustion Control is a vital factor in meeting the extra demands put on industry by the war.

Use this capable commander in your own campaign against inefficiency and waste. The Hays Combustion Control catalog, full of helpful steam-power data, tells how. Send for it today.

THE MODERN SYSTEM *It's Electrical*

HAYS *Automatic* COMBUSTION CONTROL

THE HAYS CORPORATION • MICHIGAN CITY, IND.

Answer No. 272

How Much M-H Alkalinity Should Boiler Water Show?

Try Internal Phosphate Treatment

IT IS ASSUMED that E. O. D. wishes to determine the amount of excess soda ash to maintain in his boiler feedwater. This excess should vary under changing conditions, but usually amounts to 2 to 3 gr according to the formula 2(MO—P) —H.

E. O. D. does not mention any after-treatment in the boiler and no doubt, in trying to reduce hardness as low as possible, he is carrying quite an excess of soda ash to the boiler. Without the use of some internal treatment following the lime-soda softener, this carry-over will naturally occur and at the same time all the scale forming salts will not be removed.

It is suggested that E. O. D. leave approximately 1 gr hardness in his feedwater and use one of the less alkaline phosphates as an internal boiler water treatment to take care of the residual hardness. This can be induced into the feedwater in the form of "shots" so as to avoid feed line deposits. The control of blow-down should be based on the total solids contents and not on the alkalinity. Proper alkalinity is maintained by adjustment of chemicals added to softener.

E. O. D. does not state his operating pressure, but it is assumed to be less than 250 psi. The attached chart should help. A 2-to-1 sulfate-carbonate ratio should be maintained and the total solids limited to 3500 ppm. It is suggested that total solids be controlled according to the sulfate content. The ratio of 3 times the sulfate radical or 2 times sodium sulfate will be accurate enough for all practical purposes.

If E. O. D. would follow this chart and keep his boiler conditions within or near to the correct control area, he should have no further trouble from carry-over due to chemical conditions. In addition, he should be able to prevent any new scale deposits, and consequently keep his boiler on the line for much longer periods.

St. Louis, Mo. W. J. WRIGHT

Answer No. 276

How Improve This Furnace?

Not Furnace Size but Draft Is Important

VERTICAL, low-pressure boiler with a grate 3 ft in diameter is not too big to heat five rooms of a large, old-fashioned house which, in all probability, has very high ceilings. A grate 3 ft in diameter has about 7.1 sq ft of surface. If anthracite is burned, it probably will weigh about 55 lb per cu ft. Certainly the fuel bed does not need to be over 12 in. deep. This would mean a total of 390 lb coal on the grate, at the most. Perhaps a depth of 8 in. would be sufficient. This would be equivalent to only 260 lb. But even if we were to assume that we should start with about 400 lb, this initial amount would have no relationship to the amount burned per hour per day.

After the boiler reaches the desired pressure and the radiators are hot, it is only necessary to add whatever fuel is needed to take care of heat losses. This would be true regardless of the size of the fire box and grate, or kind of boiler.

It seems absurd to even raise the question of cutting down the size of the grate. I would be much more concerned about control of the draft. When burning anthracite or coke with low sulphur content, there should be a butterfly damper in the smoke pipe. This damper should be synchronized with the ash pit draft door by means of chains and pulleys. When the fire is banked and the draft door is closed, the butterfly damper also should be closed or partly closed. With such control, a small amount of coal sprinkled on the fuel bed will hold a long time. If the coal does not contain much ash, the grates *should not be shaken too often.* Coal will not burn unless it is given air and if the heating load does not require much coal, why then—just don't burn it.

Also, I would be much more concerned about the insulation of the house and the efficiency of the heating system than the size of the fire box. A large, old-fashioned house probably has large windows which should be insulated with storm sash. If there is a large open stairway, it should be closed off.

The effectiveness of the method of returning condensate to the boiler should be checked and the air valves on the radiators should not be neglected.

Whether or not the boiler and steam pipes should be insulated depends on whether heat is needed in the basement. However, some people make the mistake of insulating the boiler and piping so thoroughly that the basement is cold and this makes the floors on the first floor cold. Basement windows should be insulated with storm sash.

The location of the radiators and their manner of installation may have an important bearing on the amount of fuel which can be saved. Once I acted as consultant in revamping a heating system in an old mansion which had been taken over by a charitable organization for an office building. All of the radiators had been set into grilled enclosures which served as seats or shelves under the various windows. The grill work had rather small openings to begin with and to make matters worse, women office workers had placed potted plants over the openings at the top of these box-like enclosures. This resulted in practically no circulation of air around the radiators and the heat which they were supposed to give up to the air in the rooms was sealed in almost as effectively as if the radiators had been covered with insulating material.

I had carpenters tear out all of these window seats. In several places, after we had dug the radiators out of their tomb, we found that several of them water-logged—they sloped the wrong way.

One room which had been so cold that no one wanted to work there, was kept at a comfortable temperature after the enclosures had been torn out, using only one radiator smaller than the two which had been originally installed. It was found that there was sufficient space between the wall and the radiator to install a 12 in. propeller type fan, running at the lowest of three speeds. This distributed the heat to all parts of the room and eliminated cold floors.

Correcting such conditions as these are far more important than attempting to reduce the size of the grate surface. Whether the grate has 3 sq ft or 7 does not change the total number of Btu required to heat a given number of cubic feet of room space. A larger grate merely means a lesser amount of fuel burned per square foot of grate area per unit of time.

Naperville, Ill. J. R. DARNELL

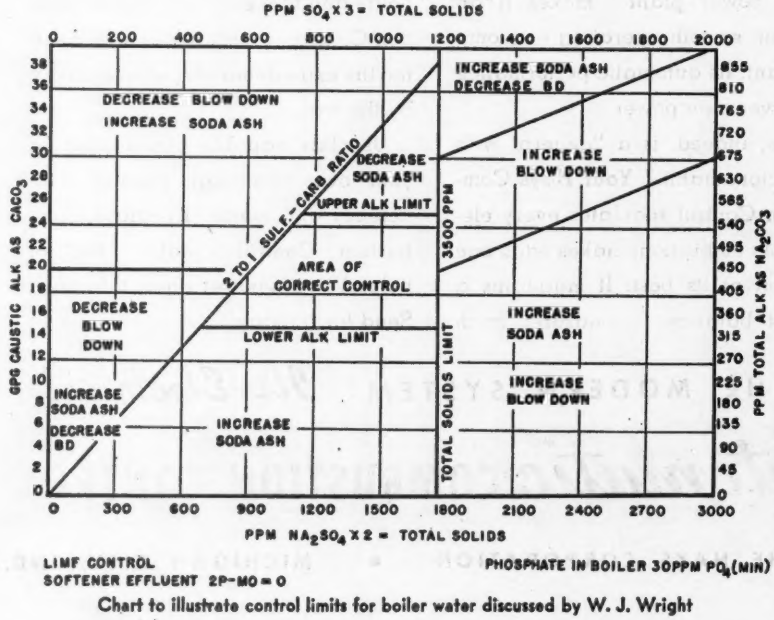


Chart to illustrate control limits for boiler water discussed by W. J. Wright

1908

Introduction of thermal expansion type regulator invented by James W. Copes. The first real step toward effective feed water control.

1913

Copes Engineers announce new and revolutionary method of feed water control—"continuous feed varying with load, and level varying inversely with load."

1916

Initial research on flow through control valves, leading to design for individual boiler conditions.
First 6-inch regulator ever made installed at Delray Station, Detroit Edison Company.

1917

Research into the influence of excess pressure variations on feed regulation, resulting in development of first differential pressure devices.

1918

Development of rotary stem control valves to reduce stem friction to low and constant amount, as against high variable friction of sliding stem.

1919

Manufacture of Copes Regulators begun in foreign countries. Within a few years Copes became the accepted standard in Europe, Asia, South Africa.

1920

Copes Regulators installed on 1100 psi. European-built boilers when 450 psi. was highest pressure in the United States.

1921

Originated tight seating valve fittings having equal upper and lower seat areas. Patent granted.

Leaders and Specialists for 36 Years in

BOILER FEED WATER CONTROL

NORTHERN EQUIPMENT CO. *1241 Grove Drive, Erie, Pa.*

Feed Water Regulators • Pump Governors • Differential Valves • Liquid Level Controls • Reducing Valves & Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND — REPRESENTATIVES EVERYWHERE

1924

Copes Regulators designed with expansion tubes in TENSION set new record in simplicity and reliability. Patent granted.

1926

First successful multiple element feed water control—Copes—installed at Ford Motor Company.

1927

Copes installed on first 1400 psi. boilers in the United States—Boston Edison Company.

1928

Basic patents secured on combination of feed water regulator and differential pressure valve.

1930

First 8-inch feed water regulator—a Copes—installed at New York Steam Company.

1932

After careful tests and investigations, all radio controlled ships of U. S. Navy equipped with Copes Regulators.

1934

Six years' research completed with development of first valves really balanced under operating conditions.
Patents granted on 2 types of 3-element regulators.

1937

Patents granted on remote control of feed water regulator and other control valves.

1938

Produced the Copes Flowmatic, a 2-element regulator—recognized as one of the greatest advancements in the art of feed water control for modern boilers.

1941

Introduced a Copes Marine Regulator not influenced by roll or pitch of the vessel. Now installed on hundreds of ships.

1942

Copes Flowmatics installed on largest forced circulation boiler in the world—650,000 lbs. per hour at 1825 psi.—Montaup Electric Company.

194X

Peacetime application of developments and improvements fostered by intensive war production activities.

Flow of Steam Through Pipes

Velocity 6000 feet per minute

Initial Gauge Pressure Pounds per square inch		NOMINAL SIZE OF PIPE													
		2½	3	3½	4	4½	5	6	7	8	9	10	12	14	15	16
		ACTUAL INTERNAL DIAMETER OF STANDARD PIPE														
		2.066	2.469	3.068	3.548	4.027	4.506	5.046	6.064	7.023	7.981	8.940	10.020	12.000	13.250	14.250	15.250
		Weight of Steam (W) in Pounds Per Minute and Loss of Pressure (P) in Pounds for 100 Feet of Pipe														
50	W	21.01	29.98	46.30	61.91	79.72	99.87	125.3	180.9	242.6	306.3	393.2	493.8	708.3	863.5	998.8	1144.0
	P	2.84	2.12	1.51	1.20	.99	.84	.72	.55	.45	.39	.33	.28	.23	.20	.18	.17
60	W	24.06	34.33	53.01	70.89	91.29	114.3	143.5	207.2	277.8	350.7	450.2	565.4	811.0	988.8	1144.0	1310.0
	P	3.26	2.43	1.72	1.38	1.14	.97	.82	.63	.52	.44	.38	.33	.26	.23	.21	.19
70	W	27.08	38.64	59.66	79.79	102.7	128.7	161.5	233.2	312.6	394.7	506.7	636.4	912.8	1113.0	1287.0	1474.0
	P	3.66	2.74	1.94	1.55	1.28	1.09	.92	.71	.58	.50	.43	.37	.29	.26	.24	.22
80	W	30.07	42.91	66.26	88.61	114.1	142.9	179.3	258.9	347.2	438.3	562.7	706.7	1014.0	1236.0	1429.0	1637.0
	P	4.07	3.04	2.15	1.72	1.42	1.21	1.03	.79	.65	.55	.47	.41	.33	.29	.26	.24
90	W	33.07	47.18	72.85	97.42	125.4	157.1	197.1	284.7	381.7	481.9	618.7	777.0	1114.0	1359.0	1572.0	1800.0
	P	4.47	3.34	2.37	1.89	1.56	1.32	1.13	.87	.71	.61	.52	.45	.36	.32	.29	.27
100	W	36.03	51.41	79.38	106.2	136.7	171.2	214.8	310.2	415.9	525.1	674.2	846.7	1214.0	1481.0	1712.0	1961.0
	P	4.89	3.64	2.58	2.06	1.71	1.45	1.23	.95	.78	.66	.57	.49	.39	.35	.32	.29
110	W	39.02	55.68	85.97	115.0	148.0	185.4	232.6	336.0	450.5	568.7	730.1	917.0	1315.0	1603.0	1855.0	2124.0
	P	5.28	3.94	2.79	2.23	1.85	1.57	1.33	1.03	.84	.72	.61	.53	.42	.37	.34	.32
125	W	43.44	61.98	95.70	128.0	164.8	206.4	259.0	374.0	501.5	633.1	812.8	1021.0	1464.0	1785.0	2065.0	2365.0
	P	5.87	4.39	3.11	2.49	2.06	1.74	1.48	1.15	.94	.80	.68	.59	.47	.42	.38	.35
		ACTUAL INTERNAL DIAMETER OF EXTRA STRONG PIPE														
		1.939	2.323	2.900	3.364	3.826	4.290	4.813	5.761	6.625	7.625	8.625	9.750	11.750	13.000	14.000	15.000
		Weight of Steam (W) in Pounds per Minute and Loss of Pressure (P) in Pounds for 100 Feet of Pipe														
150	W	44.70	64.16	99.99	134.5	174.0	218.8	275.4	394.6	521.8	691.2	884.4	1130.0	1641.0	2006.0	2327.0	2671.0
	P	7.64	5.66	3.97	3.15	2.67	2.19	1.85	1.44	1.19	.98	.84	.71	.56	.50	.45	.41
180	W	52.44	75.26	117.3	157.8	204.2	256.7	323.1	462.9	612.2	810.9	1038.0	1326.0	1926.0	2354.0	2730.0	3134.0
	P	8.97	6.64	4.66	3.70	3.13	2.57	2.17	1.69	1.39	1.15	.98	.84	.66	.58	.53	.49
200	W	57.58	82.65	128.8	173.3	224.2	281.9	354.8	508.3	672.2	890.4	1139.0	1456.0	2114.0	2584.0	2998.0	3441.0
	P	9.86	7.31	5.12	4.07	3.44	2.82	2.39	1.85	1.53	1.27	1.08	.92	.73	.64	.59	.53
220	W	62.63	89.89	140.1	188.5	243.8	306.6	385.9	552.8	731.1	968.4	1239.0	1583.0	2300.0	2811.0	3260.0	3743.0
	P	10.70	7.93	5.56	4.42	3.73	3.07	2.60	2.01	1.66	1.38	1.17	1.00	.79	.70	.64	.58
250	W	70.25	100.8	157.1	211.5	273.5	343.9	432.9	620.2	820.1	1086.0	1390.0	1776.0	2580.0	3155.0	3660.0	4201.0
	P	12.04	8.91	6.23	4.96	4.19	3.44	2.91	2.26	1.86	1.54	1.31	1.12	.89	.78	.72	.65
280	W	78.13	112.1	174.8	235.2	304.2	382.4	481.4	689.7	912.1	1208.0	1546.0	1975.0	2869.0	3507.0	4068.0	4670.0
	P	13.37	9.90	6.94	5.51	4.66	3.83	3.24	2.51	2.07	1.72	1.46	1.25	.99	.87	.80	.72
300	W	83.17	119.4	186.0	250.3	323.8	407.1	512.5	734.2	970.9	1286.0	1646.0	2103.0	3054.0	3736.0	4333.0	4974.0
	P	14.21	10.53	7.38	5.86	4.96	4.07	3.45	2.67	2.21	1.83	1.56	1.34	1.05	.93	.85	.77
350	W	95.97	137.7	214.7	288.9	373.6	469.8	591.3	847.2	1120.0	1484.0	1899.0	2426.0	3524.0	4310.0	4999.0	5740.0
	P	16.69	12.14	8.52	6.77	5.72	4.70	3.98	3.08	2.54	2.11	1.79	1.53	1.21	1.07	.98	.89

Velocity of Flow of Water

In feet per minute, through pipes of various sizes, for varying quantities of flow

Gallons per Minute	¾ inch	1 inch	1¼ inch	1½ inch	2 inch	2½ inch	3 inch	4 inch
5	218	122½	78½	54½	30½	19½	13½	7¾
10	436	245	157	109	61	38	27	15½
15	653	367½	235½	163½	91½	58½	40½	23
20	872	490	314	218	122	78	54	30¾
25	1090	612½	392½	272½	152½	97½	67½	38¼
30		735	451	327	183	117	81	46
35		857½	549½	381½	213½	136½	94½	53¾
40		980	628	436	244	156	108	61½
45		1102½	706½	490½	274½	175½	121½	69
50			785	545	305	195	135	76¾
75			1177½	817½	457½	292½	202½	115
100				1090	610	380	270	153½
125					762½	487½	337½	191¾
150					915	585	405	230
175					1067½	682½	472½	268½
200					1220	780	540	306¾

These two tables should be of value in making quick checks on the amount of steam or water that can be sent through pipes of different sizes at different pressures and rates of flow. The table giving the flow of steam through pipes, it will be noted, also gives the loss of pressure per 100 ft of pipe. Reprinted from the Insulation Manual of Ehret Magnesia Mfg. Co., Valley Forge, Pa.

Here is the true story of a large power plant that was caught between the horns of a dilemma... This plant operated on 100% make-up water, using about 5,000,000 pounds per day and employing no external treatment. Two sources of water were available—a natural pond and city water. Pond water was preferable because of the costs involved, but the pond was polluted with industrial wastes and whenever this water was fed to the boilers, severe carryover resulted. On the other hand, the city water was high in silica content and its use caused heavy silica scale and burned out tubes. The plant was truly between the devil and the deep blue sea!

W. H. & L. D. BETZ engineers were called in to find an economical solution to this perplexing problem. During the course of their studies test runs were made, employing the pond water together with a combination of foam-suppressing chemicals. This procedure proved to be both satisfactory and economical, and a complete system of plant control was quickly established. Under this control the plant is now operating on the low-cost pond water... and carryover has been eliminated.

This story is but one example of the many difficult water problems that are brought to W. H. & L. D. BETZ for solution. It illustrates the breadth of experience behind the Betz organization in keeping boilers "on the line".

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

BETZ

W. H. & L. D. BETZ

FRANKFORD · PHILADELPHIA · PENNA.

Water Chemists Meet in Pittsburgh

Industrial water specialists presented data on the problems of dealkalizing, demineralizing, removal of ammonia, cooling water treatment, cathodic protection, treating plants for industries, treatment with lime and limestone, sterilizing with ozone and coagulation with silicates at 5th Annual Water Conference

WITH each succeeding year the Water Conference, held for the fifth time in Pittsburgh October 30 and 31 under the sponsorship of the Engineers' Society of Western Pennsylvania, has grown in its usefulness to the water using industries. This may be due to a better understanding of the needs of industries on the part of the Conference Committee consisting of H. M. Olson, general chairman, Max Hecht, W. S. Morrison, T. J. McLaughlin, S. F. Whirl, and W. J. Murdoch, but more than likely the growing interest is due principally to the accumulation of data on water treatment for industrial purposes, the evident effort on the part of the chemists to interpret their findings to water users and the opportunity presented to water users to bring up their water chemical problems for discussion by specialists in various branches of industry. This year the registration totaled 360 persons, of whom 275 were from other states than Pennsylvania. The entire proceedings including papers and discussions will be published in bound form by the Engineers' Society of Western Pennsylvania.

The program, in almost its entirety, dealt with problems confronted in power plants and was to a large extent a recital of progress in methods and systems of treatment which have recently been put into successful use. In boiler water treatment, for example, the problem has always been to secure a feedwater that is free from impurities that will leave deposits in the boiler or steam using equipment or that will corrode, embrittle or in any way attack the metal with which the water, steam or resultant condensate may come in contact. It was with phases of this problem that the first three papers dealt, i.e., dealkalizing, demineralizing and removal of ammonia.

H. M. Olson has served as general chairman of the Water Conferences held by ESWP

Dealkalizing

Authorities seem now to be agreed that embrittlement of boiler metal is caused by local concentrations of caustic soda and slight amounts of silica, in the cracks or crevices of the metal. Extensive studies have, therefore, been made to improve methods of removing alkalinity from boiler waters. M. J. Shoemakar, Chief Chemist of the Research Products Corp., has been investigating a two-zone zeolite system for dealkalizing, and reported his findings at the Conference. He stated that in order to maintain or improve the quality and reduce the manufacturing costs in certain industries, it is necessary to remove the excess of mineral matter in most water supplies referred to as alkalinity by the water chemist.

He discussed zeolites, which are a form of filter material used to remove alkalinity from water, and older methods of their use. The disadvantages of these older methods have been overcome by means of a double filter system which has proven simpler and less costly to operate. It has been possible to obtain a remarkably level residual alkalinity by employing two hydrogen zeolite units in series.

The first may contain any type of hydrogen zeolite and is regenerated in the usual way with acid. Accordingly, the water from the first unit is more or less acid, depending upon the conversion efficiency of the zeolite therein.

The second unit floats on this line and studies to date indicate that better results are obtained if the second unit contains hydrogen zeolite of the carboxyl or weak acid type. Studies, however, on the sulfonic type of zeolite are under way.

The two zone system has been installed under various conditions of water and operation, and is proving to be a most practical means to dealkalize water and deliver a final effluent with a low uniform residual alkalinity.

Demineralizing

Pointing out that the demineralizing process for removing both cations and anions from water is the latest and most interesting development in the ion exchange field of water conditioning, M. E. Gilwood and V. J. Calise, Research Chemical Engineers, of The Permutit Co., outlined the history of the development of the demineralizing process and the principles of operation, and gave data showing the growth of the use of this process in the last seven years. Also, a list of applications and uses of the process was given together with operating data, costs and results obtained with several sizes of demineralizing plants.

The use of recycling and mixing of treated water with raw water when demineralizing a high solids water in order to reduce the sulfates and chlorides in the water to be treated, was discussed. This is done to increase the capacity of the cation exchanger and to improve the quality of the effluent. The use of vacuum deaerators to remove CO_2 and O_2 to low figures was also noted.

It was stated that the sodium zeolite softener, which was first commercially introduced about 30 yr ago, removes the cations Ca^{++} and Mg^{++} from water by exchange for Na^{+} in the zeolite. The resulting softened sodium zeolite effluent, however, contains sodium salts equivalent in amount to the total cations present in the raw water. Thus, the amount of total dissolved solids in the sodium zeolite treated water remains unchanged.

As a result of intensive research activity, products have been developed that not only eliminate the troubles encountered with the earlier materials, but in some respects, excel the well established cation exchangers, especially in capacity and regenerating efficiency. Typical of these materials is the aliphatic amine resin "De-Acidite."

"De-Acidite" has been in operation for many hundreds of cycles with only a small drop in capacity, imparting no color to the treated water and producing an effluent that remains constant in its low electrolyte content. However, this material cannot be said to have the extraordinary stability of Zeo-Karb which shows no appreciable change in capacity, even after many thousands of cycles and many years of service.

The demineralizing process is a two-step series process as shown in the diagram. The chemical action in each of the two steps is described on the diagram. The chemical action in each capacity of the Zeo-Karb H Unit has been exhausted, the unit is regenerated by passing a dilute solution of acid, usually sulfuric, through the bed. In a similar manner, the De-Acidite unit is regenerated by soda ash. The complete regeneration procedure, which consists

Engineering Serial

Each month, during the past year, Tube Turns' advertisements have pointed out one single outstanding advantage of Tube-Turn seamless welding fittings. Added together, they have told a serial story of Tube-Turn engineering and performance qualities that are of prime importance to everyone concerned with designing, specifying, buying or installing piping and fittings.

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

TUBE TURNS (Inc.) Louisville, Kentucky. Branch Offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle, Los Angeles.

TUBE-TURN
TRADE MARK
Welding Fittings and Flanges

of backwashing, regenerant introduction and rinsing to waste, requires about 1 hr for each unit and can be carried out automatically where desired.

The demineralizing process produces an effluent equal or superior to most commercial distilled water supplies. Silica is not removed by demineralizing and if a water of low silica content is desired, supplemental silica removal treatment may be employed.

Removal of Ammonia

Excessive amounts of free ammonia in both domestic and industrial waters lead to a large variety of difficulties. In domestic waters these may lead to poor bacteriological removals, to an intensification of odors and to the gradual closure of water distribution mains. In industrial waters this may lead to excessive ammonia corrosion, to the fouling of condensers or to the accumulation of organic material in the mill piping. In either case the removal or destruction of all the free ammonia present and the maintenance of free available chlorine residuals has gone far toward the alleviation of such difficulties.

According to a paper by A. E. Griffin, Ass't. Director, Technical Service Division, Wallace & Tiernan Co., Inc., this can be accomplished in one operation by the additon of chlorine in the ratio of 10 ppm or more of chlorine to each part of ammonia present. The optimum pH for completion of the reaction lies between 6.5 and 8.5 and the time of contact should not be less than 20 min. Temperature is of relatively small importance although when it drops below 45 F there will be some retardation of the reaction.

The production and maintenance of free available chlorine residuals indicates that the ammonia has been removed. This point can be determined by means of the Laux Flash Test. Through the use of this test, laboratory findings can be duplicated in plant practice. Attempts are being made to hold the ammonia contents at as low a figure as is economically possible in all parts of the power plant steam system. Several methods of ammonia removal were described and the following conclusions were drawn:

1. Free ammonia can be removed from water by chlorination.
2. The ratio of chlorine to ammonia should be 10 to 1 or more.
3. The speed of reaction between chlorine and ammonia is influenced by the pH and temperature of the water.
4. The completeness of the reaction is a function of the contact time.
5. The completion of the reaction can be determined in practice by the Laux Flash Test utilizing ortho-tolidine.

Cooling Water Studies

Industry is becoming more exacting in its demands for suitable cooling water. Requirements do not end when the water used has a sufficiently low temperature. In many pieces of equipment, heat transfer surfaces become scaled, corrosion and erosion occur, slime and sludge accumulate, all of which interfere with the transfer of heat or cause early failure of equipment.

In an effort to improve cooling water treatment and systems, Dr. H. L. Kahler, Director of Research, W. H. & L. D. Betz has conducted a series of studies on once-through and recirculating cooling waters and described at the Conference two pieces of experimental apparatus employed in his research, and gave evidence of their successful operation.

Effects of temperature, incrusting elements, metal scaling surface, hysteresis, cycles of concentration and various treatments on calcium carbonate and scale formation were given. The combination treatment of a complex phosphate and organic materials was shown to possess excellent powers to prevent the formation of scale both in once-through and in recirculating systems. Photographic evidence was shown to indicate how the employment of these treatments distorts the crystals of the scale thereby repressing its formation to a high degree.

The studies showed that increased water temperature, higher rates of heat transfer and skin temperature, and higher concentrations of the scaling elements increased the amount of calcium carbonate scale obtained. The scale prevention power of many materials was evaluated. The best treatments were blended from a complex phosphate and organic materials of the tannin type.

Rust Prevention

Although the possibilities of protection of metals from rust by electrical means have long been known and systems have been developed and used in many industrial applications, considerable experimental engineering work needs yet to be done before present available methods and equipment will be accepted by industry as a positive, adequate and economical method of preventing rust. The information contained in the paper entitled, Cathodic Protection of Steel Equipment Submerged in Water, by L. P. Sudrabin, consulting engineer, should be helpful to industry in the protection of equipment subject to rust.

Mr. Sudrabin expressed the opinion that fundamental considerations to be made in the engineering design of cathodic protection installations for mitigating the corrosion of submerged steel structures in contact with neutral waters, must be based on a thorough study of the corrosion environment.

His experience indicates that current density requirements are largely controlled by the depolarization rate processes occurring on the more cathodic areas of the corroding metal surface. Deposition of $CaCO_3$ and/or $Mg(OH)_2$ and/or Mg in the bulk of the corroding media contacting the highly alkaline film produced on the protected metal surface, creates an effective barrier to dissolved O_2 diffusion, decreasing current density requirements. Steel in contact with water containing less than 1 ppm dissolved solids, can be cathodically protected.

A probe technique for current distribution was described. Electrode-tank configurations in different waters were studied from the standpoint of proper distribution of current and operating power costs.

Use of anodic metals and external direct current potential sources for motivating current flow through the corroding media to the surface to be protected were also described.

Water Treatment for Rubber Plant

With the source of our natural rubber supply taken forcibly by our enemy during the days following Pearl Harbor, it was imperative for the nation to build as rapidly as possible a huge synthetic rubber industry to supply the military and civilian needs of our country. Rather than report on many details of experience encountered in the first year of operations, the paper by Paul J. Stein, General Foreman, Water Supply, Koppers United Co., Butadiene Division, Kobuta, covered the water and effluent treatment phases of rubber-making at Kobuta on as wide a basis as possible.

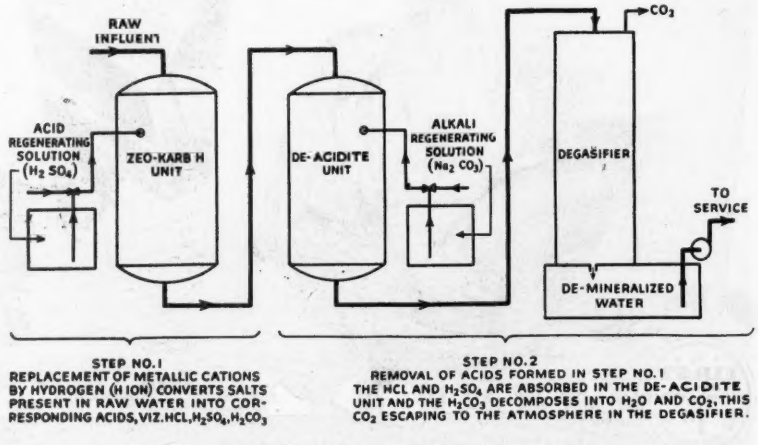
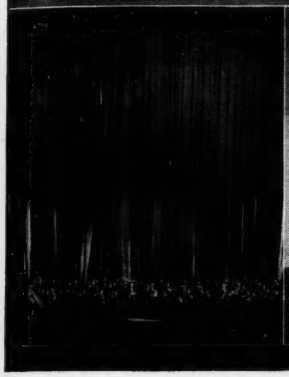

RAW INFLUENT
ACID REGENERATING SOLUTION (H_2SO_4)
ZEO-KARB H UNIT
DE-ACIDITE UNIT
ALKALI REGENERATING SOLUTION (Na_2CO_3)
CO_2
DEGASIFIER
TO SERVICE
DE-MINERALIZED WATER
STEP NO. 1
REPLACEMENT OF METALLIC CATIONS BY HYDROGEN (H ION) CONVERTS SALTS PRESENT IN RAW WATER INTO CORRESPONDING ACIDS, VIZ. HCL, H_2SO_4, H_2CO_3
STEP NO. 2
REMOVAL OF ACIDS FORMED IN STEP NO. 1
THE HCL AND H_2SO_4 ARE ABSORBED IN THE DE-ACIDITE UNIT AND THE H_2CO_3 DECOMPOSES INTO H_2O AND CO_2, THIS CO_2 ESCAPING TO THE ATMOSPHERE IN THE DEGASIFIER.

Diagram of two-step process for demineralizing water

Would you believe it?



BALDWIN supplied the hydraulic elevators that raise and lower the stage of Radio City Music Hall.

BALDWIN diesel engines are used for main propulsion units on minesweepers and for auxiliary power on many other vessels.

BALDWIN testing machine of 3,000,000 pounds capacity can be controlled so as to break the shell of a hatching egg without harming the chick.

BALDWIN hydraulic turbines, 115,000 horsepower capacity, driving huge electric power generators, are installed at Boulder Dam.

Baldwin manufactures a wide diversity of products, including testing equipment for wind tunnels, steering gears for LST landing craft, hydraulic elevators for aircraft carriers, and many other machines and instruments, serving industry on which America is depending to speed final victory.

Of course, Baldwin is well known as the builder of locomotives of all types—steam, diesel-electric and electric—doing their share of the greatest transportation job in history.

BALDWIN

THE BALDWIN GROUP

The Baldwin Locomotive Works, Philadelphia, Pennsylvania: Locomotive & Ordnance Division; Baldwin Southwark Division; Cramp Brass and Iron Foundries Division; Standard Steel Works Division; The Whitcomb Locomotive Co.; The Pelton Water Wheel Co.; The Midvale Co.

In the production of butadiene over 1000 ton of coal are consumed daily to supply the heat energy for the various distillation processes. Over 1200 lb of cooling water are required for the condensation or cooling of the distilled vapors in producing one pound of butadiene. With such huge quantities of water needed for each pound of product, very close attention was given the water supply and treating facilities.

While over 95 per cent of the water taken from the river is used for cooling purposes in which the requirements are not as severe as they are for water that is to be treated for boiler use, the River Pumping Station is located so that the best possible raw water, economically available, would be obtained. As the successful operation of the entire chemical plant is, minute by minute, dependent upon the continuous operation of the water supply system, painstaking efforts have been expended on the facilities so that they might adequately satisfy all demands.

Having an available pumping capacity that could easily handle the requirements of a city two to three times as large as the City of Pittsburgh, the River Pumping Station operates at practically maximum capacity throughout the summer months. The structure was built with a special design so that it could withstand a flood 6 ft above the 1936 crest.

The first year's pumping experience indicated that the capacity of the station must be increased before next summer if it is expected to supply water for the additional chemical facilities now being installed in the plant. To provide acceptable cooling water to the plant, all of the water is chlorinated while a portion of it receives "Threshold Treatment."

A water treatment plant, capable of conditioning 4200 gpm of river water for use in four high pressure boilers, one of which is a forced-circulation unit, is in service. Each boiler is rated at 350,000 lb steam per hr with makeup water equal to 65 per cent of the feedwater, the water conditioning system selected had to be one from which it would be possible consistently to obtain water with a low residual hardness.

The treating facilities consist essentially of three Spaulding precipitators, six gravity filters, six gravity zeolite softeners, and an acid mixing chamber of pH control. With a boiler blowdown of approximately 30 per cent during the dry season, it is quite a problem to remove such a large quantity of water from the boilers so as to maintain the recommended boiler water concentrations.

The third section of the paper dealt with the three streams of effluents. Uncontaminated water, comprising 99 per cent of the plant's effluent, is untreated, for it is not in contact with any chemicals. Contaminated water requires removal of oil, odor, taste, and improvement of biochemical oxygen demand, as well as the neutralization of the acidity. Imhoff tanks are to be utilized in the treatment of the contaminated sewage.

Water Problems of a Steel Plant

The water problems of a large steel mill such as that of the Republic Steel Corp., Youngstown, Ohio, are in many respects similar to those of industrial units in which water is needed for steam generation, cooling, sanitary and potable service for a large number of employees, fire protection and miscellaneous uses, stated E. M. Griffiths, Asst. Master Mechanic of the Republic Steel Corp. The addition of a modern power plant requires evaluation of sources of feedwater, such as city water, unfiltered water of good quality from an impounded industrial supply, and a highly contaminated river water.

The design of the purification system at this plant was dictated by specifications for feedwater quality, investment and operating costs, simplicity and flexibility to handle all three water supplies. Among several problems encountered was boiler carry-over on swinging loads due to blast furnace gas pressure variations. The successful corrective measures included changes in boiler drum internals and combustion control.

Water for the Paper Industry

Industrial plants use water for many purposes, some of which are more exacting in their requirements than others, and in some instances treatment for one purpose would spoil the water for another. The paper industry uses water in great quantities and has conducted extensive research to determine the types of water best suited for the uses intended and the most economical treatment available to secure water of proper quality.

This work has been carried on through the Technical Water Committee of the Technical Ass'n. of the Pulp and Paper Industry of which Lewis B. Miller is chairman, and who reviewed the work of his committee in a paper presented before the Conference. His paper dealt with process water quality required for the manufacture of fine papers and outlined further work planned on other grades of paper and pulp in this connection.

The effects of common constituents of surface and subsurface waters upon paper making operations and upon the qualities of the finished paper products were discussed in detail. The complexities arising in designing a suitable water treatment plant for treating raw water to fit it for process, boiler feedwater, drinking, cooling and other uses in a paper mill are indicated.

Mill wastes were discussed in relation to valuable materials recovery and stream pollution. Some of the more common and well accepted methods of white water treatment were considered from the standpoint of efficiency. The author stated that the design of the water treatment plant must be such as to fit the raw water for all of the uses in question.

This may require a certain amount of compromise in some cases in the choice of treatment; or it may require that all of the water be given a degree of treatment sufficient for some usages, while some of it is further treated to fit it for the remaining usages.

Economy of treatment must be given consideration in the choice of treatment system. Influencing factors such as local conditions, variations in volume of water treated and character of water with seasons, type of operating personnel must be considered.

Waste Pickle Liquor Treatment

In a paper by Richard D. Hoak, C. J. Lewis, and Willard W. Hodge, of the Mellon Institute of Industrial Research, procedures were given for determining the proportion of limestone or a lime which will react with an acid liquor under particular conditions. The "basicity factor" so determined is expressed as grams of calcium oxide per gram of sample and this factor varies widely with the particle size of the agent, showing that an estimation of degree of reaction from a chemical analysis can frequently be quite misleading.

As the neutralization of a pickle liquor is equivalent to the combination of calcium and sulfate ions it is necessary only to know the sulfate content of a liquor to calculate the quantity of an alkaline agent required for the treatment. A procedure was given for determining the "acid value" of a liquor in terms of grams of sulfate per liter with an accuracy of 0.2 per cent in less than a half hour.

Ozone as a Water Sterilizer

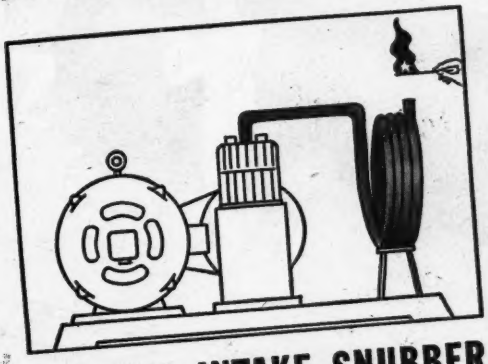
In the sterilizing of water, history shows that this water problem is not a new one and has been expanded from early ages to the latest types of water filtration plants. Ozone has been in use since it was first discovered, but not until recent years has it become harnessed to work, said N. P. Rand, President, Norwood Filtration Co., in a paper dealing with ozone as a water sterilizer.

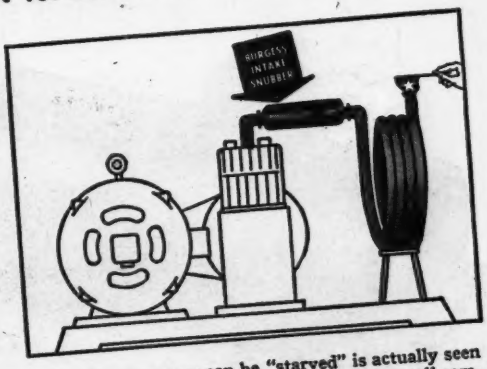
Ozone, in use, according to Mr. Rand, has compared favorably both from an economical standpoint and utilitarian standpoint to be a substitute for chemicals that have been in use over a long period of time for water sterilizing. With decreased costs of power and increase in production of units, the costs should be on a level between ozone and other methods.

Silicates for Coagulation

Sodium silicates are finding increasing application in the treatment of water, said H. R. Hay, Chemical Department, Philadelphia Quartz Co., in a paper describing the use of silicates for coagulation. Recognition of their value for corrosion control has been followed by the development of silica coagulant aids to improve purification. The soluble silicates are currently used for boiler water treatments under operating conditions of both low and high pressure.

BURGESS SNUBBER BULLETIN for Diesel Exhaust Noise Control





BURGESS INTAKE SNUBBER PREVENTS INTAKE "PANTING"

The principal function of the Burgess Air Intake Snubber is to quiet the intake. It can be used to prevent ramming, "starving," or supercharging.

Air intake noises are not always painful to the ear, but inaudible air intake pulsations may set up disturbing and even destructive secondary vibrations.

Everyone familiar with compressors knows that compressor performance may be affected by change in length of the air intake line. Some pipes may be of resonant length, causing the air column within the pipe to vibrate like an organ pipe. This impedes the intake of the air and "starves" the compressor. Others may be of half resonant length and cause overloading of the compressor motor.

How a compressor can be "starved" is actually seen in the demonstration illustrated above. The small compressor has an air intake line of resonant length. The surges of air in the intake pipe cause fluctuating air flow or "panting" of sufficient intensity to actually force the small flag away from the air intake. (See left illustration.)

The right illustration shows the same system with a Burgess Snubber in the air intake line. Now the little flag has reversed its position and is being sucked continuously into the air intake pipe. The compressor now operates at its rated capacity. All surges or pulsations have been smoothed out into a unidirectional flow. The intake Snubber has completely eliminated resonance, ramming, and intake noise.

Since air intake lines are usually a necessary evil, the safest way to obtain maximum compressor efficiency, and, at the same time, remove vibration, ramming, and other adverse effects, is to install a Burgess Air Intake Snubber near the compressor.

* * * *

120-TON SWITCHER WORKS WITHOUT "SNORTING"

Tomorrow's freight yard will be different. It will be cleaner . . . and far less noisy. There will be a conspicuous absence of puffing switch engines that snort along, belching soot-laden smoke.

Diesel power is already playing an important part in railway transportation . . . for long distance freight and passenger hauls. Now the Diesel switcher is making rapid strides providing speedy service in the railroad yards of our busy cities.

The postwar trend in Diesel switcher design is shown in the accompanying illustration. This Diesel locomotive was developed by the Diesel Locomotive Division of Fairbanks Morse & Co., and delivered to the "Milwaukee" Road at Beloit, Wisconsin.

The new switcher, identified only as No. 1802, has plenty of eye appeal and power. It is painted in a combination of silver, orange, and black. At 30% adhesion it has a tractive effort of 72,000 lbs. . . . a maximum working speed of 60 mph!

The engine is of the opposed-piston type, rated at 1,000 bhp at 800 rpm. Although built as a single unit, there are two exhausts—one taken from each side of the engine. Both exhaust lines are Burgess Snubber-equipped to remove all noise.

The manufacture of Diesel switchers will help in the conversion from war to peacetime employment.

HELPFUL INFORMATION

"Diesel Exhaust Noise Control" is a booklet containing technical subjects for Diesel operators and engineers.

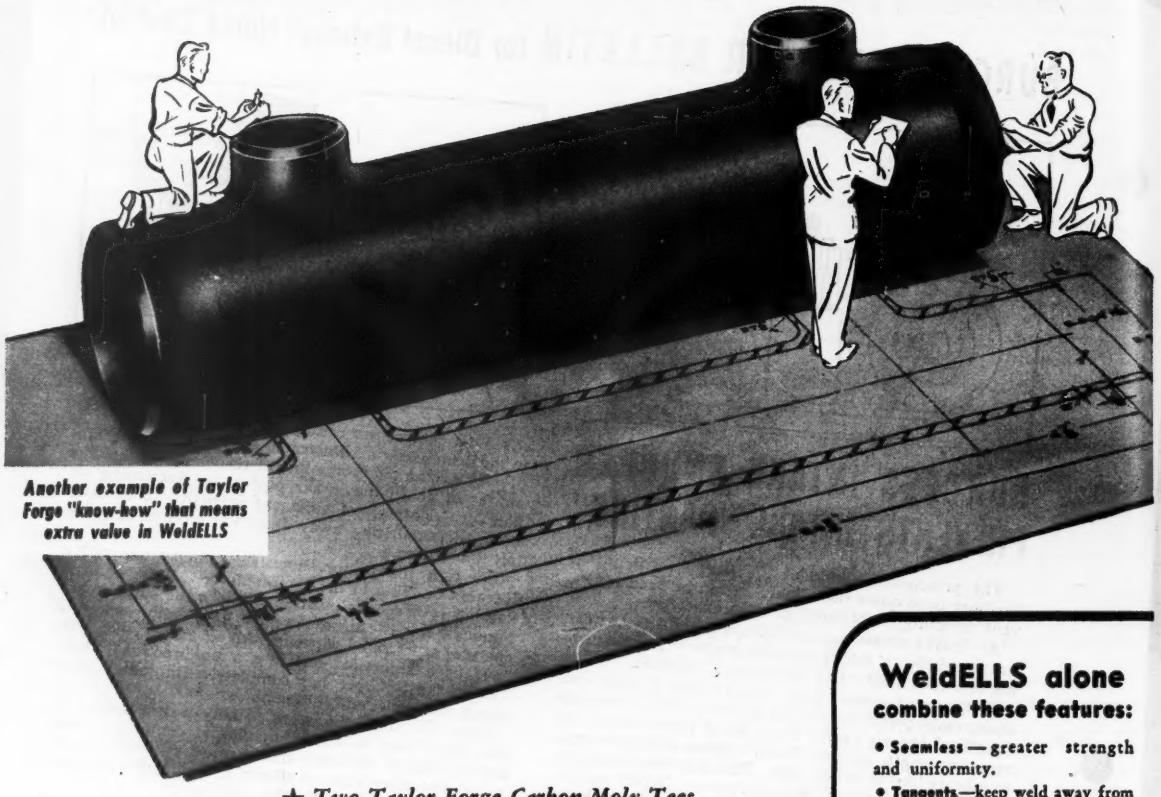
Subjects include: How Exhaust Line Piping Affects Engine Performance, How to Measure True Back Pressures, How Exhaust Pressures Vary with Crank Rotation, and others.

The booklet describes how to quiet Diesel exhausts in critical locations where excessive noise cannot be tolerated. "Diesel Exhaust Noise Control" is free and obtainable upon request. Ask for Bulletin 447.

Published by BURGESS-MANNING COMPANY Chicago, Illinois

COPYRIGHT 1944—BURGESS-MANNING COMPANY

FUSSY PEOPLE, THESE!



Another example of Taylor Forge "know-how" that means extra value in WeldELLS

★ *Two Taylor Forge Carbon-Moly Tees with a 5½" nipple welded between them would have provided an assembly with the same overall dimensions as the special "tandem outlet" 5x5x2½x2½" seamless carbon-moly tee pictured here. But this was a particularly "fussy" job with so much at stake that the engineers wanted this exact fitting.*

Quite naturally, this job wound up at Taylor Forge; for engineers throughout America have learned that the meticulous jobs—those which call for unusual skill and knowledge in the forming of hot metals—are expertly handled here.

MOST people know of Taylor Forge's reputation for doing the unusual —sometimes even the "impossible". But the important thing to recognize is that the very same factors which built this reputation also provide many extra values in our standard, stock welding fittings . . . that this ability to make difficult "specials" is reflected in the design of our regular line of WeldELLS and other Taylor Forge fittings.

That is why you find in WeldELLS a combination of features that is not incorporated in any other make. There are sound reasons for everyone of them, and the overall result is a stronger, longer lasting and . . . more *economical* piping job.

Just check the list of features opposite and we believe you'll fully agree that

WeldELLS *have everything*

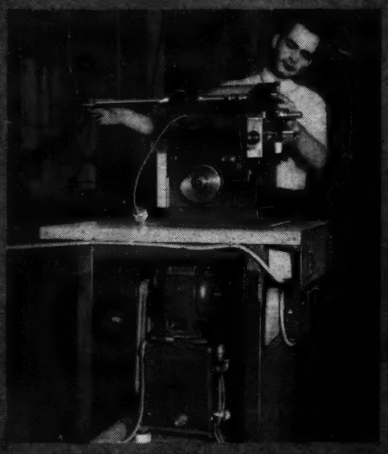
WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

CAN'T QUIVER

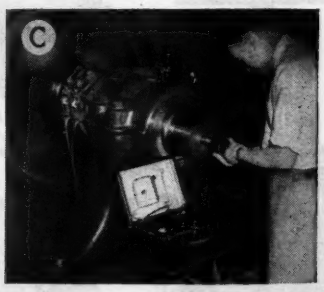
Motors driving precision machines can't quiver without affecting the work, particularly when the motor is mounted directly on the machine. The close tolerances required on so much vital war equipment have intensified the need for machines and motors that remain smooth-running, month after month, in three-shift service. Why have G-E Tri-Clad motors gone on—and stayed on—so many high-precision machines? Our test procedure for balance and vibration is an important part of the answer.



High-precision recessing machine in Waltham Watch Company plant, driven by G-E Tri-Clad motor

G.E.'s vibration tests and balancing procedure help make TRI CLAD motors smooth-running and quiet

Unmatched experience in making vibration studies, especially our work on high-speed turbines, helped us to perfect dynamic-balance techniques and devices that give assurance of smooth-running motors. Every Tri-Clad rotor is dynamically balanced, and in addition, spot-checks of assembled motors are made: (A) making an electronic dynamic-balance test on Tri-Clad rotors; (B) spot-check with G-E vibration indicator, with motors on elastic mountings; (C) portable electromagnetic tester being used on large motor. This test can also be applied to a motor installation, if desired. *General Electric Company, Schenectady 5, New York.*



GENERAL ELECTRIC

Buy all the BONDS you can—*and keep all you buy*

First in War, First in Peace—

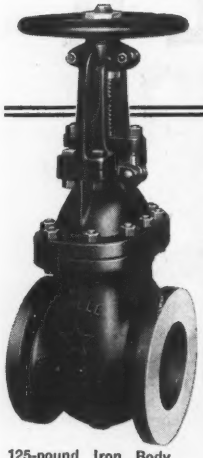
There's always a POWELL Valve for every requirement of Industry.

The "KNOW-HOW" acquired through 98 years of making valves—and valves only—has enabled POWELL Engineering to design valves to meet every problem of wartime flow control. This same "KNOW-HOW" is your assurance for the *post-war* future. Shown here are a few examples of a complete POWELL Line especially adapted to your industry. As new requirements arise, there'll be POWELL Valves to meet them.

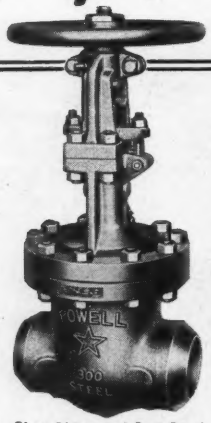
The Wm. Powell Company

Dependable Valves Since 1846

Cincinnati 22, Ohio



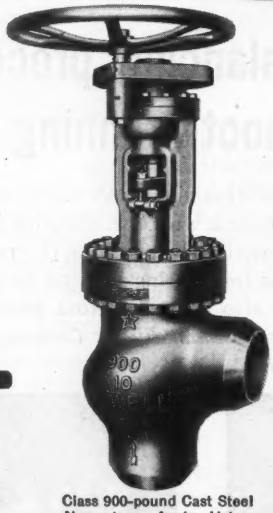
125-pound Iron Body Bronze Mounted or All Iron O. S. & Y. Gate Valve.



Class 300-pound Cast Steel Welding End O. S. & Y. Gate Valve.

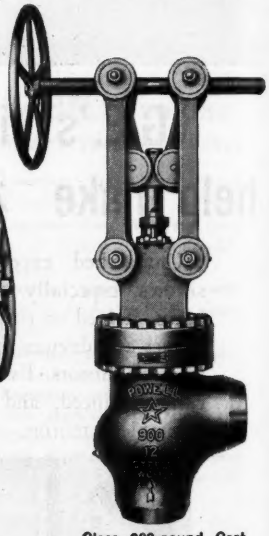
125-pound Iron Body Bronze Mounted Non-rising Stem Gate Valve.

200-pound Bronze Globe Valve with re-grindable, renewable seat and disc.

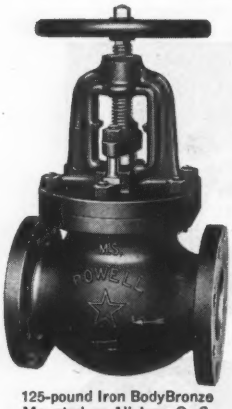


Class 900-pound Cast Steel Non-return Angle Valve, spur gear operated.

Class 1500-pound Cast Steel Welding End O. S. & Y. Gate Valve.



Class 900-pound Cast Steel Non-return Angle Valve, toggle operated.



125-pound Iron BodyBronze Mounted or All Iron O. S. & Y. Globe Valve.

Class 900-pound Cast Steel Welding End Swing Check Valve.

200-pound Bronze Gate Valve with renewable disc.

Class 900-pound Cast Steel, Gear Operated Gate Valve with welded Bonnet, special by-pass and sediment and inspection cap.

250-pound Iron Body Bronze Mounted Regrinding Swing Check Valve.

POWELL VALVES

2 WAYS TO IMPROVE COMBUSTION *whatever your fuel*

PREHEAT ENGINEERING DESIGN

All fuels burn better with preheated combustion air, and it is a "must" for many of them, such as high-moisture powdered coal. In planning new steam generation plants or other furnaces for oil refineries, chemical plants, etc., remember that the *continuous regenerative counterflow* principle of the Ljungstrom Air Preheater assures maximum heat transfer with minimum weight and size. Flexible and compact, it may be used in a wide range of applications. With the Ljungstrom it is possible to obtain preheated air up to 1500 deg. F.

All boiler manufacturers can furnish you designs incorporating the Ljungstrom Air Preheater. Or, the engineering staff of The Air Preheater Corporation is prepared to assist you, your consulting engineers or your boiler company, in applying standard or special types of Ljungstrom Preheaters to your fuel conservation needs. Our engineers are ready to work with yours to help you make better use of low-grade, more abundant fuels and to help you plan for future modernization of, and additions to, your steam generating plants.

PREHEAT ENGINEERING SERVICE

Today, when boiler efficiency must be stepped up, and kept up, to generate steam with the current inferior fuels, the need for expert service has increased. To assist you in securing efficient operation under abnormal conditions, The Air Preheater Corporation has expanded its service facilities, so that an Air Preheater Service Engineer, whose sole responsibility is Ljungstrom Preheaters, is quickly available to keep your Ljungstrom operating smoothly, and at peak efficiency.

NEW! When, for reasons of fuel conservation Ljungstrom Preheaters are operated with lower gas exit temperatures than those for which they were designed, deposits sometimes form. To do an even better job of removing these deposits, a new, single-nozzle cleaning device is available for immediate installation on *all* Ljungstroms. Full details will be sent upon request.

THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, New York

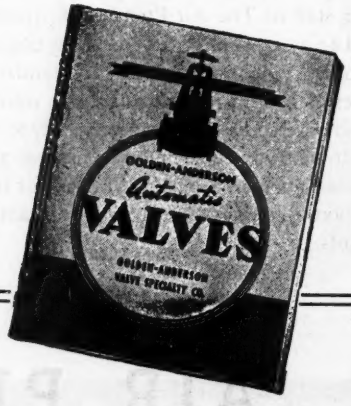
Here is Automatic Protection Against Runaway Turbines

It's the GAVSCO EMERGENCY STOP VALVE

This Throttle and Emergency Stop Valve works instantly and automatically . . . prevents any unit from exceeding safe operating speed. Its value to you lies in the fact that it permits the location of trouble **before** damage occurs.

GAVSCO Emergency Stop Valves are supplied in Angle and Globe patterns, in sizes from 2½" to 16". Valve trim may be Bronze, Monel, Stainless Steel or Gallavoy, according to pressure and temperature conditions. Seat rings and disc may be Stellited.

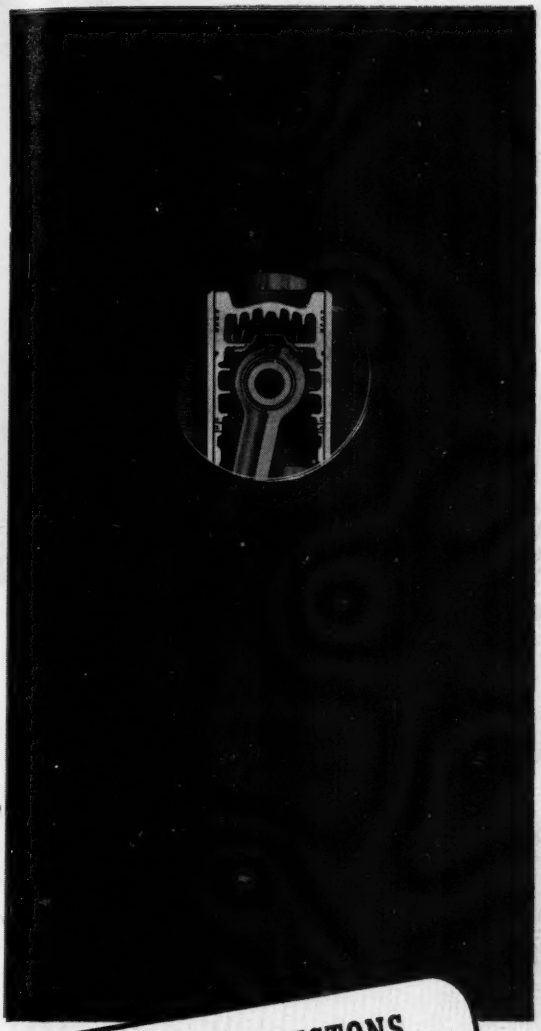
Write today for this catalog . . . describes and illustrates the complete line of GAVSCO Specialty Valves.



GOLDEN-ANDERSON VALVE SPECIALTY CO.

FULTON BLDG., PITTSBURGH, PA.

Manufacturers of Special Valves for Special Services



OIL-COOLED PISTONS

Another of 22 advanced features combined exclusively in Hendy Diesels

Among the many advanced design features in the Series 50 Hendy Diesels are oil-cooled pistons—to keep rings cool and free, improve top-cylinder lubrication, and minimize cylinder wear. Of clean, rugged design, Hendy pistons are cast in Hendy's own modern foundry to exacting specifications. Heavy ribbing under the piston head provides strength and aids correct cooling by providing maximum surface against which cooling oil is directed from a jet in the top of the connecting rod.

ONLY ONE OF MANY FEATURES

Oil-cooled pistons are but one of the many features combined by Hendy for the first time in a single engine. Others include overhead camshaft, dual intake and exhaust valves with hydraulic tappets, automatically lubricated valve crossheads and guides, and maximum accessibility through *large* inspection doors.

OIL-COOLED PISTONS INCREASE DEPENDABILITY

Correct piston temperatures are assured in the Hendy engine by means of the heavy ribbing on the underside of the pistons and by direction of a continuous stream of cool oil against the ribs. By controlling the temperature of the pistons—and their rings—a superior oil film is maintained on the cylinder walls. This has many advantages: Reduced ring wear...reduced cylinder wear...low oil consumption...freedom from stuck rings...higher operating efficiency...lowered maintenance costs. All of these factors save money for Hendy owners—and are typical of the advanced design features of these engines.

350 TO 675 HP—4 CYCLE

Whatever your requirements may be, within this power range, you will find that Hendy Diesels warrant your closest inspection—they will give you long and dependable service.

For stationary power service or combined with generators as electric power units Hendy Diesels offer a reliable, economic source of power.

A NEW CATALOG which shows many other features of the Hendy Diesel is now available. Please state your power needs and operating conditions if requesting quotations.

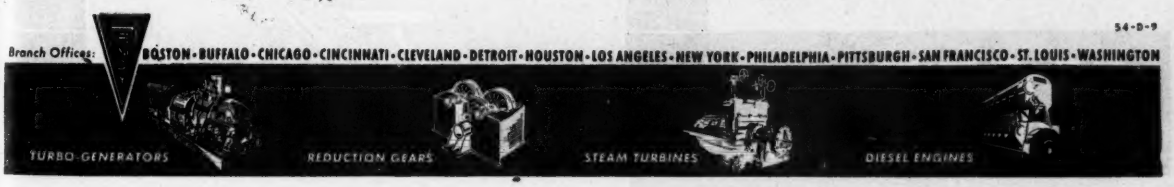
JOSHUA **HENDY** IRON WORKS

ESTABLISHED 1856

SUNNYVALE, CALIFORNIA

54-D-9

Branch Offices: BOSTON · BUFFALO · CHICAGO · CINCINNATI · CLEVELAND · DETROIT · HOUSTON · LOS ANGELES · NEW YORK · PHILADELPHIA · PITTSBURGH · SAN FRANCISCO · ST. LOUIS · WASHINGTON



"CATHEDRAL of FLAME"

THIS is the fire chamber of a giant boiler — a veritable cathedral of flame. Its vaulted interior extends beyond the height of an eight-story building. Along its walls and ceiling are more than 12 miles of Globe Steel Tubes — steam lines that produce driving power for huge turbo-generators. Globe boiler tubes successfully stand up against the intense heat and high pressures created by this steam generating operation.

Our engineering staff plus excellent laboratory facilities and production capacity, recommends, tests and produces the right tube for your most exacting requirement. Always specify Globe steel tubes. Send for Bulletin 103A which contains interesting technical data on Globe Tubes.

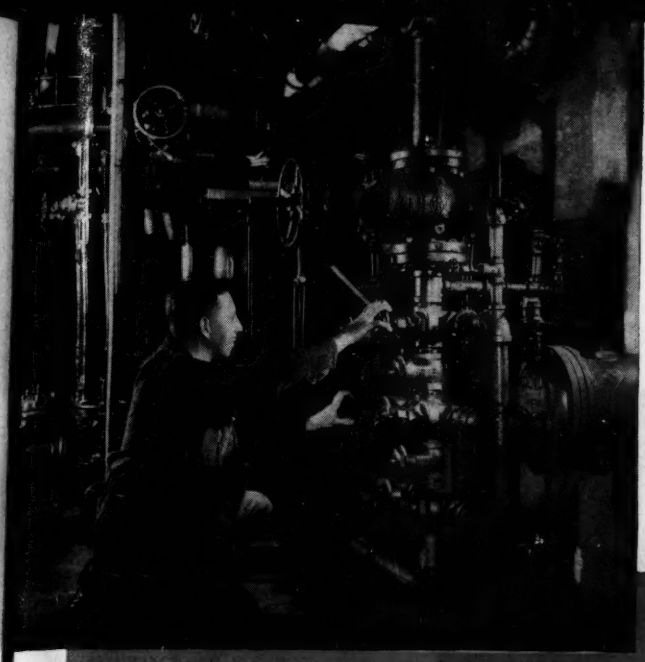
1103

GLOBE TUBES

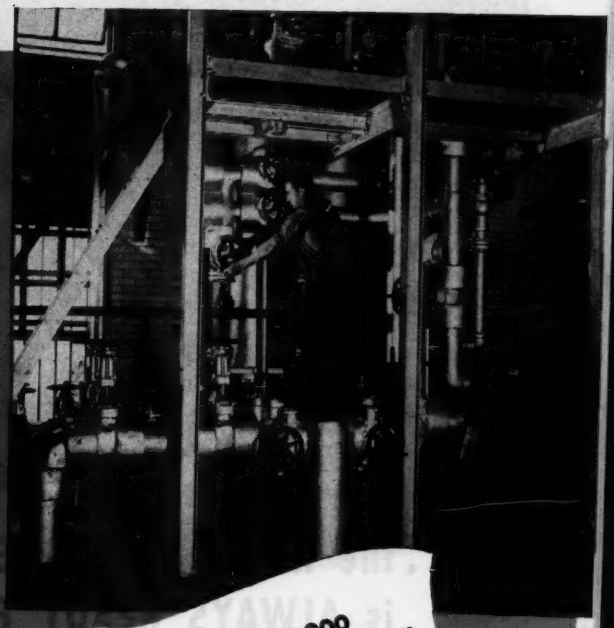
★ STAINLESS TUBES
★ BOILER TUBES
★ GLOBEIRON TUBING
★ GLOWELD TUBES
★ CONDENSER AND HEAT EXCHANGER TUBES
★ MECHANICAL TUBING

GLOBE STEEL *Tubes*

GLOBE STEEL TUBES CO., *Milwaukee 4, Wis., U. S. A.*

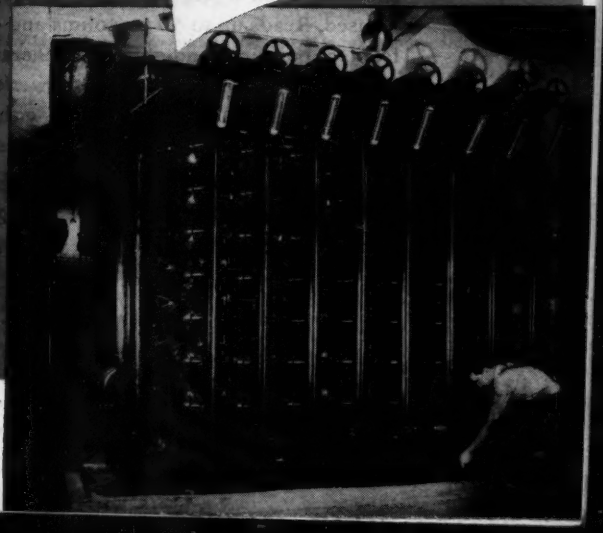


More than 3,784,320,000 valve-hours -without a shutdown due to valve failure



OVER 36,000

Jenkins Bronze and Iron Valves in Globe, Gate, Check, Needle, Angle and Y patterns, from 1/8" to 24", control the flow of vital fluids through many mechanical operating units and over 110 miles of pipeline in this modern giant medical center.



New York Hospital finds Jenkins Valves unequalled for trouble-free operation and low maintenance

A hospital takes no holidays . . . every unit of mechanical equipment must be in service every hour of every day, and the valves that control this equipment must meet exceptional standards.

That is why the men responsible for the efficient operation of the New York Hospital plant chose Jenkins Valves for all except services requiring valves of special design.

Mr. W. W. Downey, Director of Engineering, says, "Jenkins Valves at the New York Hospital have operated 24 hours a day, every day, for the past twelve years without a shutdown due to valve failure". Some 36,000 valves are installed, making a total of over 3,784,320,000 valve-hours of trouble-free service, a record that continues to increase daily.

Low maintenance was another reason for the choice of Jenkins Valves. Because of the Jenkins "family" design, a relatively small number of interchangeable parts needs to be kept to repair a large number of valves. Also, fewer man-hours are required for maintenance, an advantage which proved helpful when personnel was lost to the armed forces.

In your plans for new construction, reconversion, or renovation, it will pay you to specify these valves that "cost least in the long run". You can completely equip your plant or building with lifetime-service Jenkins Valves - there are types, patterns and sizes for practically every need.

Jenkins Bros., 80 White St., New York 13; Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago; Jenkins Bros., Ltd., Montreal; London.

Jenkins Bros.

JENKINS VALVES

SINCE 1864

For every Industrial, Engineering, Marine and Commercial Service . . . In Bronze, Iron, Cast Steel and Corrosion-resisting Alloys . . . 125 to 600 lbs. pressure.

Sold Through Reliable Industrial Distributors Everywhere

Small . . . but MIGHTY!

. . . the MIDGET "MEGGER"* TESTER is ALWAYS READY FOR USE . . . ANYWHERE

Weighing but 3 pounds, this mighty midget can be carried in a coat pocket or tool kit . . . instantly available for testing insulation resistance of practically all types of electrical equipment . . . indispensable for maintenance and trouble shooting, even where the higher range "Megger" sets could be used. Reads up to 50 megohms and delivers 500 volts d-c from a built-in hand-cranked generator, making it independent of batteries or external power supply.

If you are not already familiar with this smallest and in many ways the most remarkable instrument bearing the "Megger" trademark, write for Bulletin 1545-PE.

Trade Mark Reg. U. S. Pat. Off.

Ask also for Bulletin 1735-PE describing the new U. S.-made "Megger" Testers.

JAMES G. BIDDLE CO.

1211-13 ARCH STREET • PHILADELPHIA 7, PA.

Children, Trees and Power Lines

(*Continued from page* 94)

should not have been foreseen that a tree of this sort, with many low hanging branches, readily climbed by youngsters, would attract a child to climb into a position of peril. * * *

"It seems to us that it was easily within the province of the jury to conclude that the tree was not sufficiently trimmed; that it was not properly guarded to prevent its being climbed; that warning signs should have been placed upon the tree or the tree condemned and removed; and, finally, that the clearance between the wire and the tree was not sufficient. * * * Judgment affirmed." (254 N.W. 106)

Conclusion

The foregoing cases are typical, both as to facts and judicial reasoning, of a long line of cases; cases all too familiar to power line executives, and presenting operational danger points difficult to guard against. For even with the most rigid inspection of power line routes, danger spots may be overlooked, or created by changing conditions.

So, while falling short of insurance, the exercise of constant vigilance would seem the best protection, and the only practical way of, at least, minimizing the risk of accidents of the kind here involved. And, as examples of the importance of such preventative care, and the liability possibilities of a slip-up in the field of Children, Trees, and Power Lines, the cases reviewed are of force and value.

Power Facilities at TVA's Fontana Dam—Correction

R. A. Hopkins, one of the authors of this article, published in the November, 1944 issue, is Head Electrical Engineer of TVA, not Head Mechanical Engineer as given in the article. Our apologies to Mr. Hopkins. His title was correctly given on the original MS and we cannot now discover how the change got through three separate proof readings, designed specifically to prevent such errors. It is the sort of unreasonable thing that makes editors grow old before their time.

Hendy Power Plants Ordered For Soviet

Thirty large turbo-generator units for the devastated power plants, factories, and cities of the Soviet Union have recently been ordered from the Joshua Hendy Iron Works of Sunnyvale, Calif. Preliminary work is now under way on the sets, of which 10 will deliver 2000 kw each and the remainder 500 kw each. The power plants, it is understood, will be used as package units to supply electricity in ravaged areas recaptured by the Russians from the retreating Germans.

CONTROLLED QUALITY ASSURES

Ladish green-colored forged steel Long Welding Necks are produced with the same rigid metallurgical control of quality and identity that typifies all Ladish products.

Complete range of sizes in pressure ratings from 150 through 1500 p.s.i. in both carbon and alloy steels.

Steel identity stamped on each flange was pioneered by Ladish and has been a Ladish standard for many years

TO MARK PROGRESS

ARMY E NAVY

FITTINGS DIVISION

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

MILWAUKEE SUBURB

District Offices:

Lincoln Building, New York City — Rockefeller Building, Cleveland
Peoples Gas Building, Pittsburgh — Sterling Building, Houston
Petroleum Building, Los Angeles

FOSTER REGULATION ENGINEERING

Saves Maintenance Time

for example:

1 Major overhaul, when necessary, without breaking the line

3 Guide and spring easily replaced

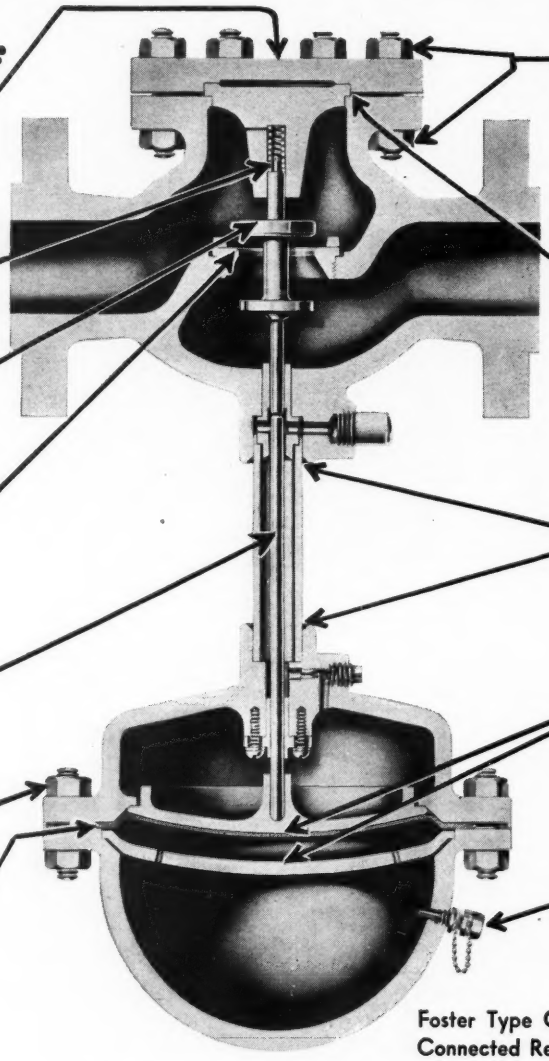
5 Main valve accessible — easily reseated

6 Main valve seat ring replaceable

7 Pushrod removed from lower end

2 All bolts are *stud* bolts — easily loosened

10 Diaphragm unit can be removed without disturbing rest of valve



2 All bolts are *stud* bolts — easily loosened

4 Ground joint — no gasket required

8 Brazed — no packing required

9 All smooth contact surfaces for diaphragm

11 Air fitting replaceable

Foster Type Q-1 Air Dome Loaded — Direct Connected Reducing Valve for Steam Service

Foster Regulation Engineering, built into each valve, is your assurance of years of accurate trouble free operation.

★ BUY MORE BONDS ★

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS... PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

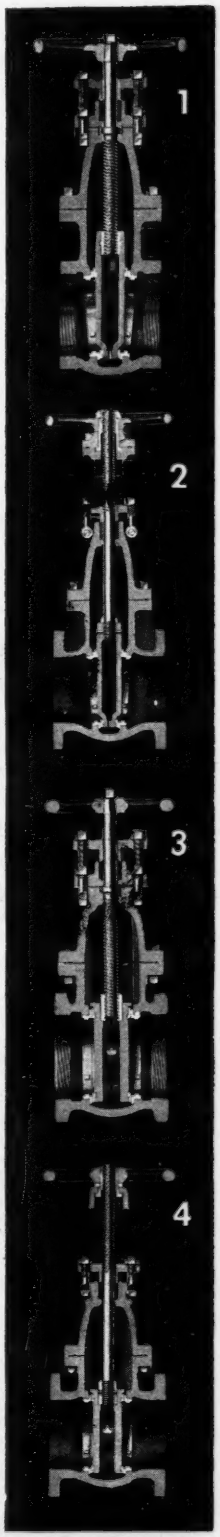
111 MONROE STREET • NEWARK 1, N. J.

12-FE-2

Here is a simple chart for GATE VALVE SELECTION

Gate valves should be used where unrestricted flow is important. They should be used on lines where they will either be wide open or fully closed. They are not suitable for throttling or flow regulation.

TYPE	CHARACTERISTICS
WEDGE GATE	Can be installed in any position. Generally considered best for steam service. Have no loose internal parts to rattle or vibrate.
DOUBLE DISC	Generally considered best for liquid and gas service. Should not be installed in an inverted position.
OUTSIDE SCREW AND YOKE	Best for high temperature service. Advisable for corrosive service as stem threads are outside of valve chamber. Stem threads can be cleaned and lubricated. Position of stem indicates position of disc. Must have sufficient headroom for travel of stem when valve is open.
NON-RISING STEM	Necessary where headroom is limited. Undesirable on high temperature or corrosive service as stem threads are in contact with fluid or gas. There is no outward indication as to position of disc.



1. Kennedy Standard Wedge Gate Valve with Non-rising Stem
2. Kennedy Standard Wedge Gate Valve with Outside Screw and Yoke
3. Kennedy Standard Double Disc Gate Valve with Non-rising Stem
4. Kennedy Standard Double Disc Gate Valve with Outside Screw and Yoke

The large Kennedy valve line includes iron-body and bronze gate, globe, angle and check valves for steam pressures up to 300 lb. and water pressures up to 600 lb. Catalog 63 describing all the Kennedy valve types in detail, together with Kennedy Pipe Fittings and Fire Hydrants, will be sent on request.

KENNEDY

VALVES • PIPE FITTINGS • FIRE HYDRANTS

THE KENNEDY VALVE MFG. CO. • ELMIRA, N. Y.

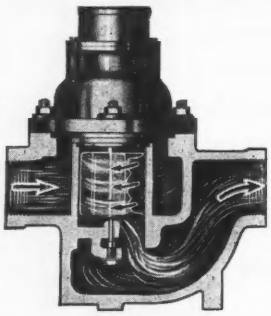
GRANDMA *Guessed*

and got away with it!

BUT MODERN LARGE SCALE FOOD PROCESSING DEMANDS ACCURACY

and that's why a large midwestern meat packer specified

HENSZEY FEED WATER METERS



Here's how it works

Water enters the measuring chamber tangentially, spinning in the chamber as it passes through, forming a vortex. Each gallon that passes through this chamber makes the same number of revolutions of the water. A vane is placed in the rotating water to impart this rotation to the register. A minimum of working parts without close clearances.

for a particularly tough assignment of measuring in a food processing job. After the installation of four Henszey Meters the results were so satisfactory that within a year two repeat orders were sent in.

If you have a tough liquid measuring job that demands accuracy—investigate Henszey Meters. They are equally accurate at high or low flow—high or low pressures—on reciprocating or centrifugal pumps. Calibrations can be made to read in gallons, pounds, or cubic feet at any specified temperature. The entire meter is easily installed right in the line.

Write today for information—this may be the answer to a long-standing problem in your plant.

HENSZEY COMPANY

Dept. C12 Watertown, Wis.

HENSZEY

FEED WATER METERS

Continuous Blowdown ● Distillation Systems ● Heat Exchangers

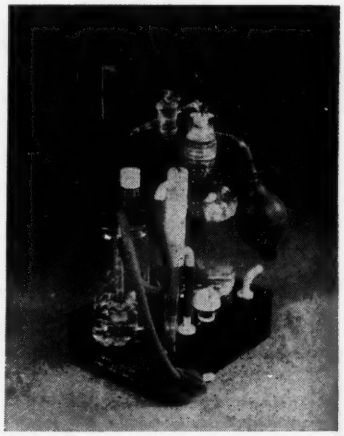
Flow Indicators ● Boiler Feed Regulators ● Proportioning Valves

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE TO POWER PLANT ENGINEERING

Water Analysis Apparatus

THE AERO-TITRATER, a product of Chief Chemical Corp., 55 W. 42nd st., New York 18, N. Y., has been developed to furnish the plant operator and laboratory technician with a rapid precise method for the determination of hardness, calcium and magnesium in waters, both industrial and potable. False endpoints are absent, and air agitation eliminates tedious and arm breaking shaking by hand. The accuracy of the instrument is comparable with lengthy and laborious gravimetric methods and substances ordinarily present in water do not interfere at all. The apparatus



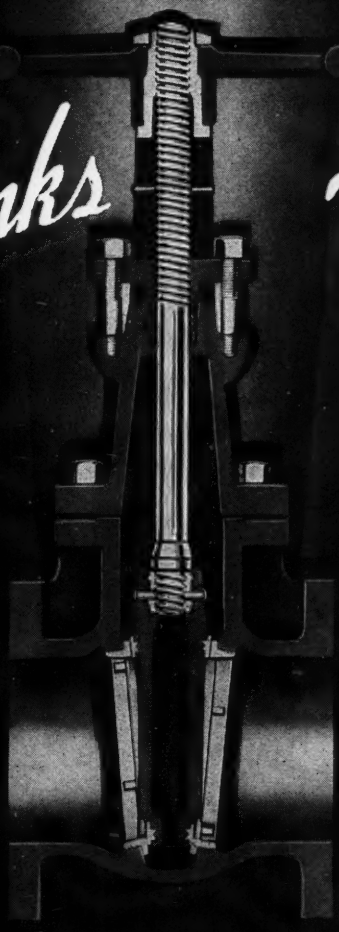
makes use of a new endpoint based on the foam-meter principle. This endpoint is unmistakable and is reproducible with a high degree of precision. The instrument has no moving parts nor delicate features to go out of adjustment and all parts are of durable plastic construction. It supplants the standard soap method for all uses, and is more precise and rapid. It is also usable with waters which resist analysis by the traditional soap method.

Multiple Cartridge Purifier

IMPROVEMENTS have been made by Honan-Crane Corp., 117 South St., Lebanon, Ind., in Honan-Crane "M" Type Purifiers which are designed to use single or multiple cartridges in standard groupings of from 1 to 38 according to the capacity needed.

Some of the outstanding features include: high flow rate, cartridge type refill elements are used in standard size 7 5/16 by 18, direct connected or bulk station use, uses either fullers earth or navy type cotton waste cartridges, used cartridges easy to remove and replace, cartridge when loaded with contamination weighs approximately 30 lb and is easy to lift from purifier, double decking of two cartridges saves valuable floor space, operation of purifier with exception of changing cartridges is entirely automatic and does not require

Fairbanks Valves



Fairbanks Iron-Body O. S. & Y. Gate Valves give an unobstructed full flow.

Having an outside screw and yoke, the operating threads on stem are outside the bonnet, consequently they are entirely removed from contact with fluids. This is of particular value in handling acids or abrasives which might wear the threads.

For use on corrosive services which attack bronze trimmings, these valves can be supplied in all-iron construction.

Their extreme ruggedness and uniform wall thickness provide adequate strength resistance to distortion.

Made for 125 and 250 lb. S.W.P. and 400 lb. W.O.G. pressures.

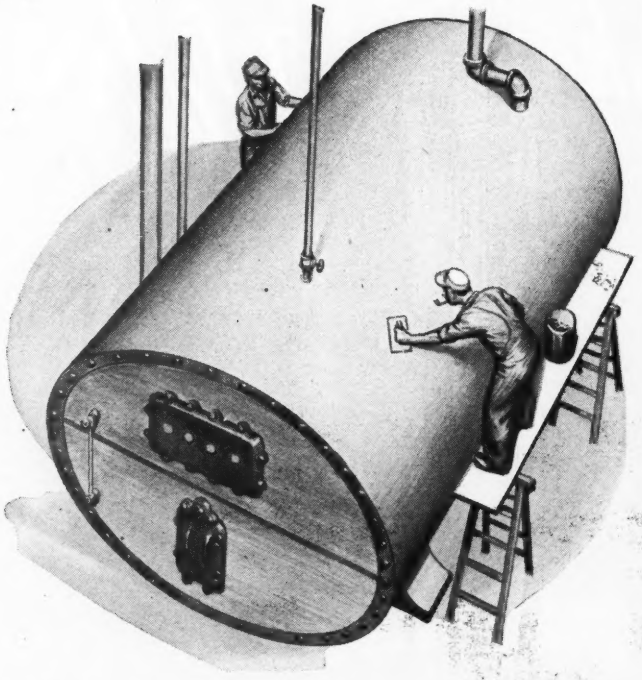
Write for name of our nearest distributor and Catalog No. 42 showing complete line of Fairbanks Bronze and Iron Valves.

THE FAIRBANKS COMPANY

393 Lafayette St., New York 3, N. Y.

520 Atlantic Ave., Boston 10, Mass. • 15 Ferry St., Pittsburgh 22, Pa.
748 M. & M. Bldg., Houston 2, Tex. • Factories: Rome, Ga. and Binghamton, N. Y.

★ The makings of a BEAUTIFUL FRIENDSHIP



★ This bond with metal survives a lot of punishment . . .

Even *rust* can't come between metal and B-H No. 1 Cement! A special rust-inhibitor prevents corrosion and assures a permanent bond—whether the cement is applied on a hot surface and dried instantly or slowly air-dried over a period of time.

No. 1 Cement is made—by an exclusive process—of high-temperature-resisting, nodulated B-H *black* rockwool and other ingredients. Because it does not form a homogeneous mass, the *black* rockwool retains its physical characteristics; the countless *dead-air cells* provide full insulating efficiency up to 1800° F.

The cement retains sufficient elasticity to absorb normal expansion and contraction, without peeling or cracking. Easily applied without skilled labor; 100% reclaimable up to 1200°.

Please write for a practical sample and complete data.

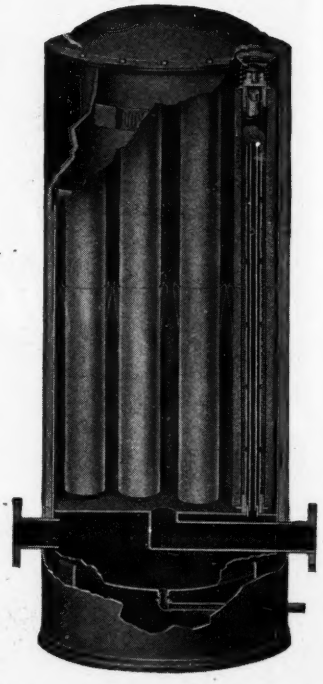
For one-*block* insulation—at all temperatures up to 1700° F.—write for illustrated data on MONO-BLOCK.

***Address:* Baldwin-Hill Co., 577 Klagg Ave., Trenton 2, N. J. Plants in Trenton, N. J.; Kalamazoo, Mich.; Huntington, Ind.**

Baldwin-Hill

COMPANY

HEAT & COLD INSULATIONS



additional labor to operate, necessary heat can be supplied by either electric heater bands, water or steam, entire unit is compact and takes up very little floor space, pump and motor can be mounted in base.

Several recent changes in engineering design have greatly simplified the changing of cartridges in these purifiers. Cartridges can be removed by turning knob which unlocks the handle from the center tube. Handle is lifted off and cartridges are easy to lift off of the center tube. New cartridges are slipped on the center tube and handle locks in position. Spring on handle securely holds cartridges in position.

Plastic Packing

GREENE, TWEED & Co., 4377 Bronx Boulevard, New York 66, N. Y., has introduced a new development of Palmetto Plastic Packing.

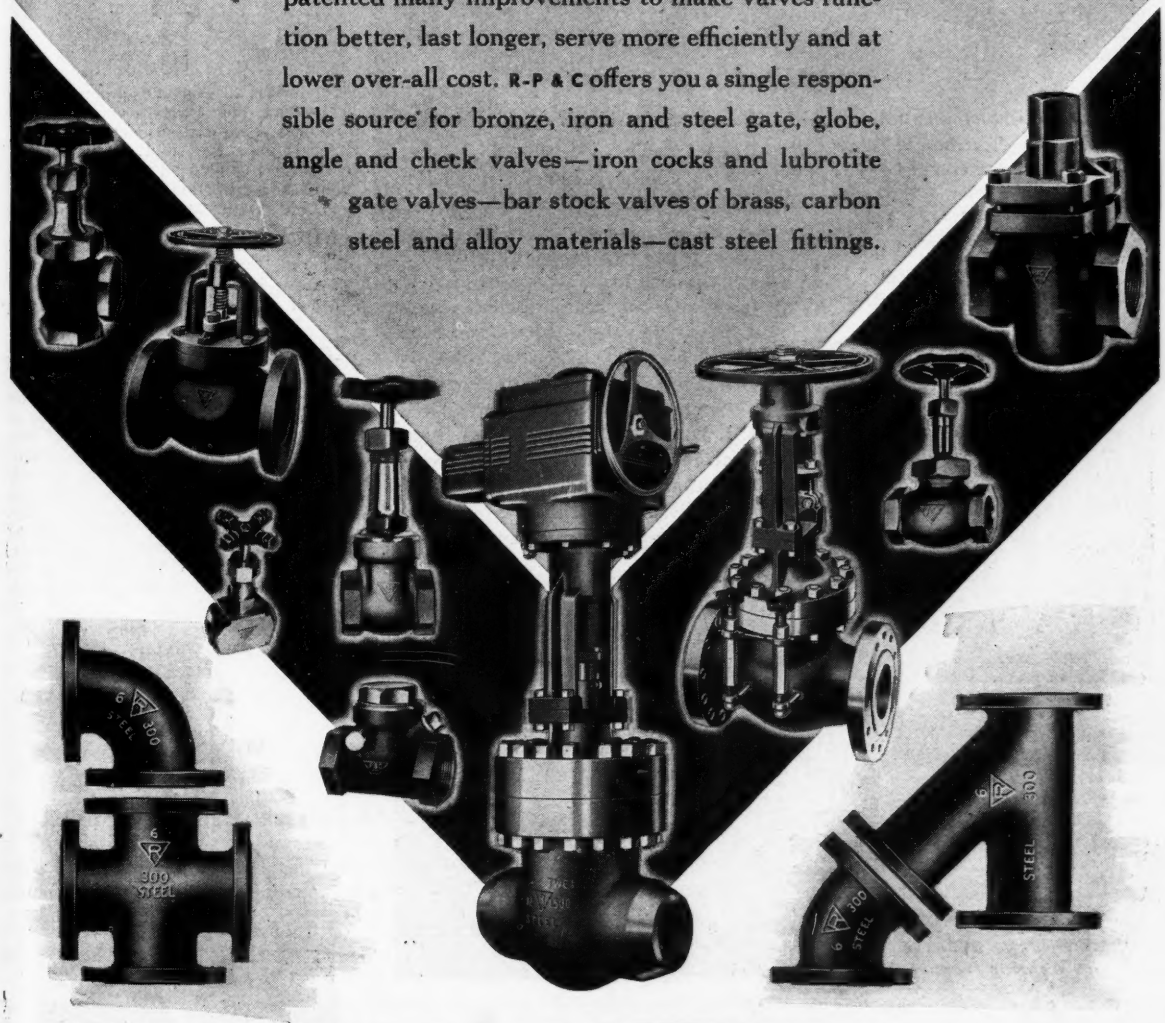
In this new packing, lasting lubricating effect is obtained by combining graphite with flakes of soft, anti-friction metal. These two lubricating agents are distributed evenly throughout long line fibres of best grade asbestos, and the whole thoroughly mixed with a special heat-resistant binder. The mixture is then formed into continuous lengths by an extruding operation which gives the packing a square outline. This shape may be altered, if necessary, to suit special requirements as compression, rolling or pounding do not impair the usefulness.

In service, the asbestos makes a strong, heat-resisting bond, the binder gives resiliency and stability under pressure, and the graphite and metallic flakes minimize frictional wear.

This packing is recommended for air, ammonia, gases, water, mild chemicals and general services at temperatures not exceeding 550 F. While not intended to replace braided or plaited packings, this plastic packing has been found to give highly satisfactory service.

Remember THIS WHEN YOU NEED *Good Valves*

READING-PRATT & CADY has been making good valves for many years—has, in fact, originated and patented many improvements to make valves function better, last longer, serve more efficiently and at lower over-all cost. **R-P & C** offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—iron cocks and lubrotite gate valves—bar stock valves of brass, carbon steel and alloy materials—cast steel fittings.



READING-PRATT & CADY

MANUFACTURERS OF

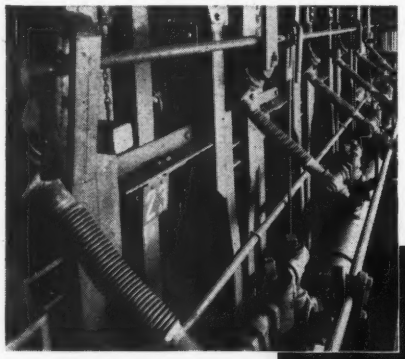
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
D'ESTE VALVE AND ENGINEERING SPECIALTIES

Reading, Pa., Atlanta, Boston, Chicago, Denver, Houston, Los Angeles, New York, Philadelphia, Pittsburgh, San Francisco

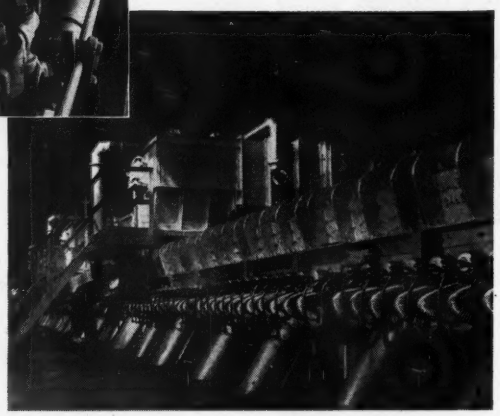
A DIVISION OF AMERICAN CHAIN & CABLE COMPANY, Inc., BRIDGEPORT, CONNECTICUT

MODERN industry is full of jobs that are "too hot to handle"—applications at high temperature levels, which often burn out ordinary connections not built to take extreme heat. But REX-WELD works efficiently at temperatures up to 1,000° F. and burst pressures up to 11,000 p.s.i. Result: fewer delays . . . lower maintenance costs.

Alert engineers have been quick to recognize the superior characteristics of rugged, flexible REX-WELD for feeding gas to industrial burners . . . for connections on coke ovens . . . heavy-duty steel mill service . . . and many high and low pressure steam, oil, and hydraulic requirements. REX-WELD is available, braided or unbraided, in sizes from ⅛" to 4" I. D. (incl.), with soldered or reattachable Rex-Tite heat-proof mechanical couplings in male or female, swivel or solid types. Write for complete information today.



(At Top) Rex-Weld Equalizer connections on annealing furnace. (Above) Rex-Weld conveying coke oven gas.



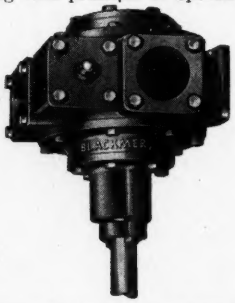
Rex-Weld type RW-80 on pipe welding furnace.

Flexible Metal Hose for Every Industrial Use

CHICAGO METAL HOSE CORPORATION
MAYWOOD, ILLINOIS
Plants: Maywood and Elgin, Ill.

Truck Pumps

Two NEW truck pumps, in capacities of 50 and 90 cpm have recently been put into production at the Blackmer Pump Co.'s plant at Grand Rapids, Mich. While these new pumps differ in appearance and in certain details of construction from the present model the bucket design swinging vane principle of operation that

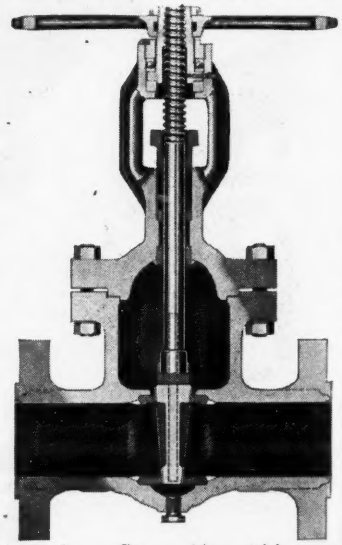


characterizes all Blackmer pumps is used. The outstanding construction feature is the double anti-friction bearings, one on either side of the rotor. This bearing construction is intended to eliminate shaft "whip" and distortion.

These pumps are compact and light in weight, are designed for standard power take off drive, and will deliver their rated capacity at 460 rpm. A relief valve is built into the pump casing and will bypass the entire capacity of the pump.

Steel Gate Valves

A COMPLETE new line of cast steel gate valves has just been placed on the market by The Edward Valve & Mfg. Co., Inc., East Chicago, Ind. Close fitting wedge guide ribs are constructed by a new method which eliminates unnecessary and wear-producing drag across seating faces. Seat rings of the new valves are hard surfaced and welded integrally to the body. Specially built fixtures permit hydrostatic test of both seating faces simul-



taneously. Gate valves 4-in. and larger are ball bearing equipped, and the smaller size bearing plates for yoke bushings are specially fitted to reduce operating effort. These valves are built in 300, 600, 900 and 1500 psi classes and in sizes for 2½ to 12-in.

STRENGTH

FOR SAFETY AND LONG-TIME SERVICE

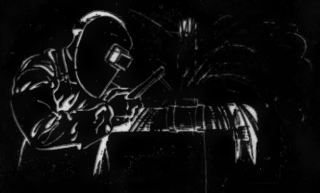
Specify

Vogt

DROP FORGED STEEL FITTINGS

SCREW END TYPE

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"



SOCKET WELD TYPE

For schedules 40, 80 and 160 pipe — Sizes 1/8" to 6"

Round-the-clock operation of oil refineries, chemical plants, steam plants, etc., essential to the continuous flow of war products to the United Nations, is all in the day's work for these fittings. Today, as in peacetime, Vogt drop forged steel fittings make a major contribution to the efficient functioning of pipe lines in plants vital to the war effort.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy.

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE 10, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Here's DART'S DOUBLE FEATURE

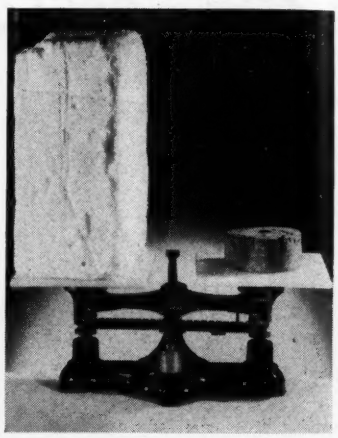
Two bronze seats ground to a true ball joint—that's the double feature that makes Dart the *better* union. Because of this superior construction, the Dart Union forms a leak-proof joint without jamming—may be uncoupled instantly if needed in another location. Body and nut—made of high-test air-refined malleable iron—are practically unbreakable. Longer lasting, Darts cost less in the long run. Tell your supplier to send you Darts.

DART UNIONS **DART UNIONS LIVE LONGER**

E. M. DART MFG. CO., Providence 5, R. I.

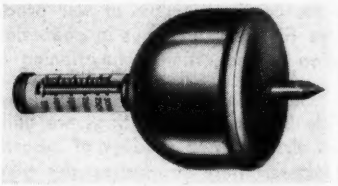
Flotofoam Insulation

U. S. RUBBER Co. has announced the development of a plastic foam weighing only one-seventh as much as cork, and having many important war uses. It will, however, be applicable in peacetime as insulation for trains, airplanes, automobiles, and homes. In lifesaving equipment such as life preservers and floats and as buoyancy units on pleasure craft, this plastic foam will provide extreme buoyancy with minimum weight. Although it has extremely important uses it is semi-rigid in structure, and has sound-deadening properties in comparison to its weight. It weighs less than a pound and a half a cu ft and can be made to weigh as little as three quarters of a pound per cu ft. In its manufacture a combination of synthetic plastic materials are foamed and then solidified. The product is called flotofoam because of its buoyancy.



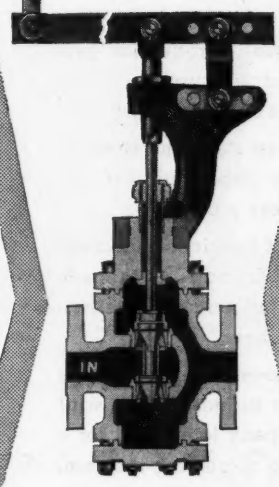
New Type Tachometer

AN ALTOGETHER new form of Tachometer has been developed for the use of engineers and time-study groups by the Standard Machinery Co. of Providence, R. I. The instrument weighs but 5½ oz and is a size 2¼-in. in diam, that permits one hand manipulation. The recording in rpm is read without the use of any time or counting device. The range of this instrument runs from 500 to 3000 rpm and is reported that the instrument shows a variation of less than 3 per cent from absolute accuracy over the whole range. A pointed contact spindle is a part of the instrument for use with shafts that are centered and an elastic tip is furnished that will slip over the pointed spindle for use on shaft ends that are not centered. The Tachometer is dust and moisture proofed and has a baked enamel protective coating on all surfaces except the scale, which is enclosed in a plastic tube.



★ DEPENDABLE ★ GENERAL ★ PURPOSE ★ DIRECT ★ ACTING LIQUID LEVEL CONTROLLER

Sectional View, Type 220C-7B with high-tensile iron or cast steel float cage, screwed equalizing connections.



FEATURING: FISHER'S NEW IMPROVED LEVER VALVE

- ★ Sturdy built, high tensile iron yoke with ribbed reinforcement
- ★ Positive guide in yoke structure for valve stem
- ★ Bronze guide bushing
- ★ Stainless steel link pins, ground and polished
- ★ Adjustment for various valve travels

Fisher Type 220C-7B is an ideal general purpose level controller for controlling and maintaining liquid levels in absorbers, accumulators, stills, feed water heaters, receivers, and other similar applications. It is designed to assure long, trouble free service on heavy duty or severe operating conditions.

The improved yoke construction of the lever valve is furnished as standard with all steel valve bodies in sizes up to 6". Also available with iron body valves.

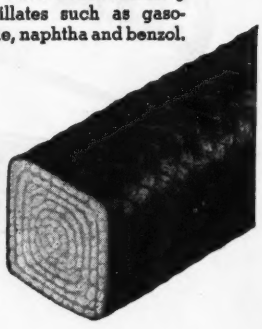
For dependable trouble free service, *specify Fisher Type 220C-7B Liquid Level Controller.*

FISHER
GOVERNOR COMPANY
1023 Fisher Building
MARSHALLTOWN • IOWA

BELMONT PACKINGS

FOR GASOLINE SERVICE
Belmont 6100

For rod and valve stems handling volatile distillates such as gasoline, kerosene, naphtha and benzol.



FOR HOT OIL SERVICE
Belmont 189

For rods and plungers handling hot or cold oil—all temperatures.

For OIL

PACKINGS are important in every plant production program. They keep the machines of industry turning—help speed from assembly lines America's weapons of war.

AND . . . now, when equipment must stand the strain of 24-hour-a-day operations—it's vitally important that just the right packings be selected for every job.

Above are two of the many Belmont Packings especially made for petroleum services. Both 6100 and 189 are made from asbestos yarn, braided and treated with suitable lubricants for maximum operating efficiency.

Any Belmont distributor (they are located in every large industrial center) will be glad to offer suggestions on your requirements. Or write on your company letterhead for a copy of the Belmont Packings Catalog displaying the complete Belmont Line.

THERE'S A BELMONT PACKING FOR EVERY SERVICE

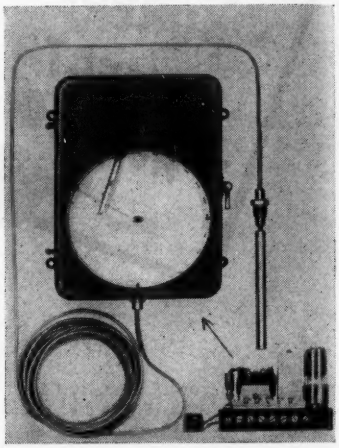
Steam, Water, Oil,
Gas, Air, Acids,
Alkalies, Ammonia

Rings, Spirals, Coils,
Reels, Spools, Sheets,
Gaskets.

THE BELMONT PACKING & RUBBER COMPANY
BUTLER AND SEPVIVA STREETS • PHILADELPHIA 37, PA.

Automatic Control Instruments

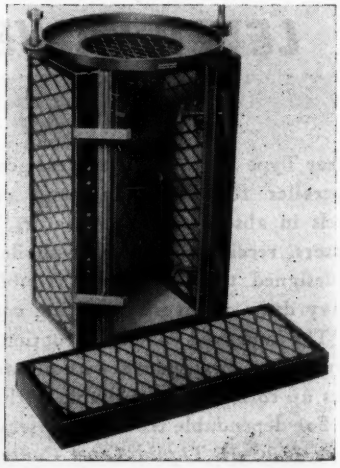
THE BRISTOL CO., Waterbury 91, Conn., has announced the development of a new electronic-type controller known as Bristol's Free-Vane Electronic Controller. The line operates on the shielding effect of a vane passing between two coils in an electronic circuit. Both recording and indicating models are offered for automatic control of temperature, pressure, liquid level, and humidity. The controller for temperature is offered in ranges for −125 F to +1000 F for use in conjunction with motor and solenoid valves, relays, main line switches, and



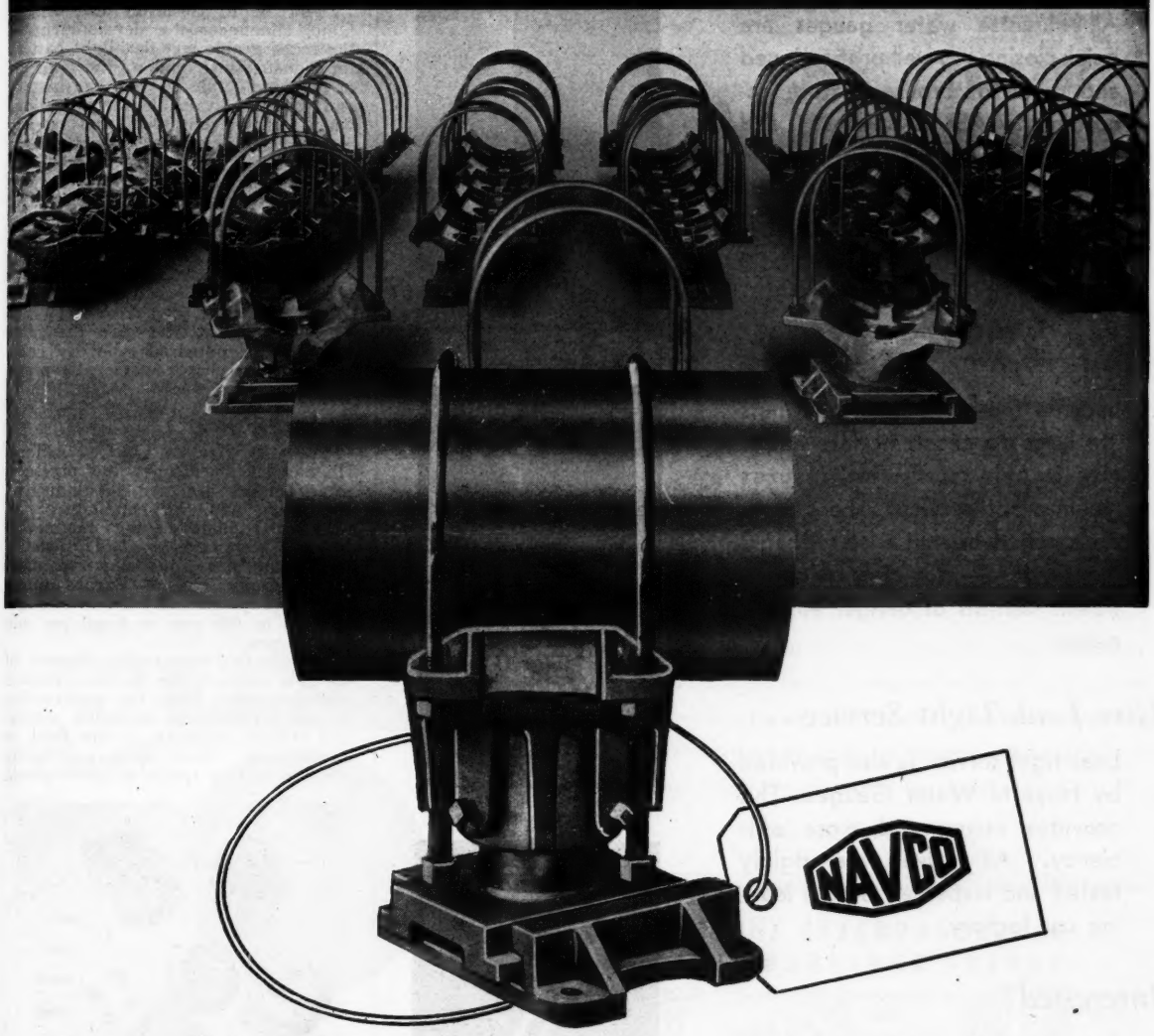
other fuel control apparatus for controlling the temperature in electric, oil, gas fired, and steam-heated ovens, dryers, dehydrators, oil baths, smoke houses, tanks, and other similiar industrial apparatus. The pressure controller is available in ranges from full vacuum to 6000 psi and in addition is available for automatically controlling liquid level. The humidity controller operates from a wet and dry bulb type of element with separate control for each bulb. The Free-Vane Electronic Controller is also offered as a time-program controller.

Diesel Air Filter

EMPLOYING an entirely new design, the Farr Co., 2615 Southwest Drive, Los Angeles 43, Calif., has developed an air filter weighing 46½ lb and hav-



NAVCO "UNIVERSAL" PIPE SUPPORTS



Navco Universal Support will take care of eight inches of expansion and can be made special to accommodate any amount of travel.

Vertical adjustment up to 2½ inches can be made.

Support may be turned to any angle of 360°.

Holds pipe down as well as up. Prevents pipe from getting out of alignment, which is usual in the Roller Type of support.

It permits control of expansion movement of pipe and insures the desired free action of Slip Expansion Joints so essential in tunnel and duct work.

Carrier is fixed to a predetermined point on the pipe, thereby eliminating possibility of destroying insulation. There is a recess in the saddle for insulation and the entire support can be insulated on the outside.

Navco Universal Pipe Supports are made of cast tion and the entire support can be insulated on the prices. For installations exposed to the weather, bases can be furnished with brass liners or provided with forced lubrication.

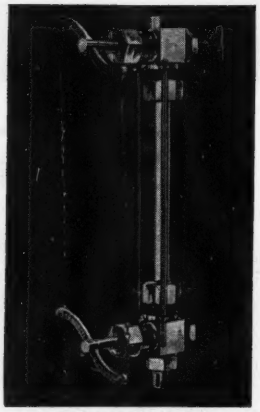
NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

ATLANTA BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA

Precision Made HUYETTE WATER GAUGES

Meet ASME Code . . .

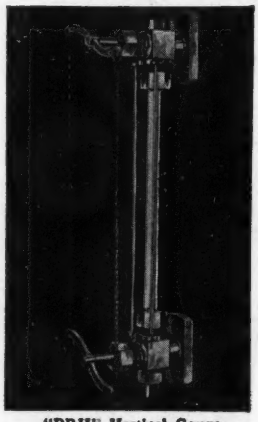
All Huyette water gauges are quick closing . . . well proportioned and made of bronze mixture according to ASME Code . . . and stamped with maximum working pressure. These features assure you of meeting today's demands for equipment that will last long and give 24-hour-a-day service



"PBH" Vertical Gauge (Screwed connection)

Assure Steam-Proof Service . . .

Because the glass and steam nuts are large to accommodate ample size packings, "PBH" insures steam-proof service. The gauges are opened or shut by less than a quarter-turn—providing quick, efficient shut-off of danger and expense.



"PBH" Vertical Gauge (Flanged connection)

Give Leak-Tight Service . . .

Leak-tight service is also provided by Huyette Water Gauges. This provides saving and more efficiency. All valves are rigidly tested and inspected before leaving our factory.

"PBH" Tiltview Gauge (Patented)

Interested?

For complete details and specifications on all "PBH" water gauges, sizes, working pressures and pipe connections, write for Bulletin #741. Contains useful charts, tables, photographs. Write today.

The PAUL B. HUYETTE COMPANY, INC.

Established 1896

401 N. BROAD ST., PHILADELPHIA, PA.

ing a capacity of 2200 to 3200 cfm, the unit being known as the Far-Air Diesel Air Filter, and is used to clarify intake air for Diesel engines. It is composed of four separate filter panels of characteristic Far-Air design—herringbone channelled fine wire screen—and 2⅜-in. thick. They are mounted with spring clips on a steel frame.

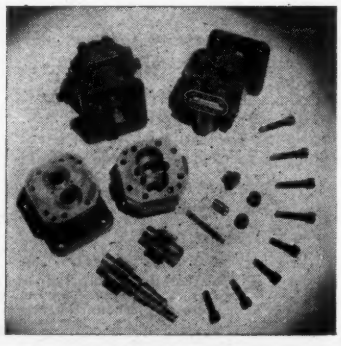
Rechargeable Flashlight Battery

THE B. F. GOODRICH CO., Akron, Ohio, announces the development of the rechargeable wet flashlight battery for industrial use built on the principle of the automobile wet storage battery and especially valuable for operations where long continued and steady usage of flashlights is necessary. These batteries are reported to be particularly useful at the present time when dry cells are in critical supply and when long life is so important for uninterrupted flashlight service. They claim to be more economical than dry cells when flashlight service is required in volume, or where batteries require replacements more than once every two weeks. The batteries give the same light as the industrial type dry cells, and a freshly charged wet battery will give about three hours constant light.

Rotary Pump

JOHN S. BARNES CORP., Rockford, Ill., has developed a new low pressure, rotary pump, designed for industrial application and the handling of all types of liquids having lubricating qualities such as oil, gasoline, benzine, vegetable oils, naphtha, and turpentine. The capacity of the Barnes pump ranges proportionately from one gal per min at 600 rpm to 4 gal per min at 2400 rpm.

A principal outstanding feature of the new pump is the Barnes patented spur gear tooth form, the construction of which eliminates excessive sliding, and reduces slippage of the fluid to a minimum. Each tooth completely fills the mating space, as gears mesh,

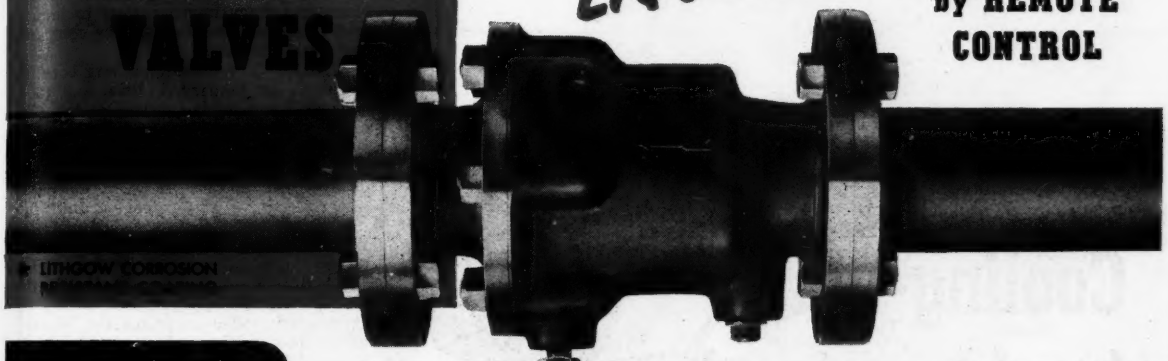


and perfect sealing action is effected, thus securing positive displacement of the fluid. The spur gears, which are made of special alloyed cast iron, are cast integral with the shaft itself and the shafts are precision machined to bearing limits to rotate in the bore of the pump housing which eliminates the need for bronze or roller bearings.

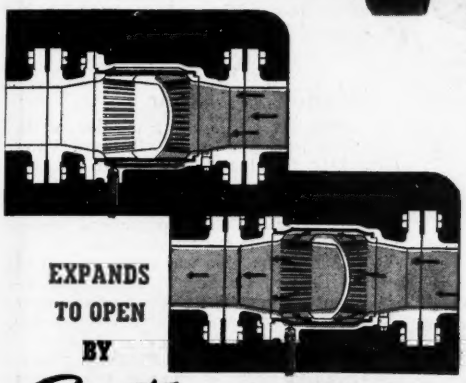
An important feature of the pump is the self priming arrangement. The maximum pressure range is 200 lb per sq in. and it is reported that tests show vacuum created to 26-in. mercury gage. The weight of the pump is 3½ lb.

GROVE
INNER-COATED*
FLEX-FLO
VALVES

HANDLE
CORROSIVE
LIQUIDS AND GASES
by REMOTE CONTROL



* LITHGOW CORROSION RESISTANT COATING



EXPANDS TO OPEN BY *Remote Control*

Grove FlexFlo Valves employ just one (non-metallic) moving part —a flexible synthetic rubber tube which expands to open and contracts to close. Therefore, there are no rubbing surfaces—no seats, discs, stuffing boxes, etc., to wear, stick or leak. All inner surfaces of the valve are completely protected with resilient Lithgow synthetic coating which impregnably resists highly corrosive fluids and gases, and eliminates any possibility of electrolytic action. Line fluid is hermetically sealed off from the external operating medium by the flanged lips of the cylindrical expansible tube which is securely anchored within the valve body. External remote control operation of the FlexFlo Valve may be affected manually, automatically or in combination with automatic control instruments.

Write for Bulletin 800 Today.

THE ORIGINAL EXPANSIBLE TUBE TYPE VALVE

UTILIZE *ANY* EXTERNAL SOURCE OF FLUID PRESSURE SUPPLY

GROVE FLEX-FLO REMOTE CONTROL VALVES

GROVE
SIMPLICITY
ACCURACY
SAFETY

GROVE REGULATOR COMPANY

6491 GREEN STREET, OAKLAND 8, CALIFORNIA. *Branch Offices:* 30 Rockefeller Plaza, New York 20 • 5644 Navigation Boulevard, Houston 11, Texas • 1930 West Olympic Boulevard, Los Angeles 6, California

WRITE TODAY FOR BULLETIN 800

PLANT UNDER CONSTRUCTION!

Cooling-water troubles stop here!

Hundreds of industrial plants have installed the Wallace & Tiernan Desliming Process to *remove* and *prevent recurrence* of slime accumulations in their cooling water systems. If, however, you are planning a new plant, you can *forget* cooling water slime problems by including a Wallace & Tiernan Desliming installation in your specifications. Installation with initial construction permits reductions in size, weight and investment in basic heat exchange equipment.

With the Wallace & Tiernan Desliming Process condenser tubes are always slime-free, costly blowing or plugging is avoided, vacuums are continuously maintained at or above the manufacturer's guarantee —*and the unit is kept on the line.*

Whether you are planning to build a new plant, or to increase the productive capacity or efficiency of your present one, why not let Wallace & Tiernan Engineers give you the benefit of their experience?

Write for technical information

CD-9

WALLACE & TIERNAN

PRODUCTS · INC.

Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey • Represented in Principal Cities

OBITUARIES

C. C. Worthington

CHARLES CAMPBELL WORTHINGTON, retired president of Henry R. Worthington Corp., now Worthington Pump and Machinery Corp., died at his home in Washington, D. C., on October 21 at the age of ninety years. Mr. Worthington was the son of Henry R. Worthington who invented the direct-acting steam pump and many improvements to industrial equipment and founded the company that bears his name.

Charles C. Worthington was born in Brooklyn on January 6, 1854, and took a general engineering course at the Columbia School of Mines. In 1875, he joined his father in business, becoming owner of the company in 1880 at the death of his father. He held the office of president of the company until his retirement from the pump business in 1900. He was the inventor of the Worthington high duty water works engine and hydraulic machinery, and the Worthington gang lawn mower used widely on golf courses. He organized the Worthington Mower Co. and was at one time associated with the Holley Steam Pump Co.

Walter W. Mohr

WALTER W. MOHR, a member of the engineering staff of The Edward Valve & Mfg. Co., Inc., East Chicago, Ind., for 24 yr, died Monday, November 13 at St. Margaret's Hospital in Hammond, Ind., after an illness of several weeks. Death was due to complications.

Mr. Mohr, who was chief engineer of the Edward Co. for 16 yr, was the inventor of numerous types of valves, valve operating mechanisms and valve design improvements.

Born in Hanover, Germany, forty-eight years ago, he came to this country as a young man and made his home in Sheboygan, Wis. Six years later he came to the Calumet area and after a few months with a Chicago engineering firm, he joined the Edward Co., with which he has been associated ever since.

He is survived by his widow, Kathryn, a daughter, Mrs. Patricia Delismon, and a son Warren. His home was in Calumet City, Ill.

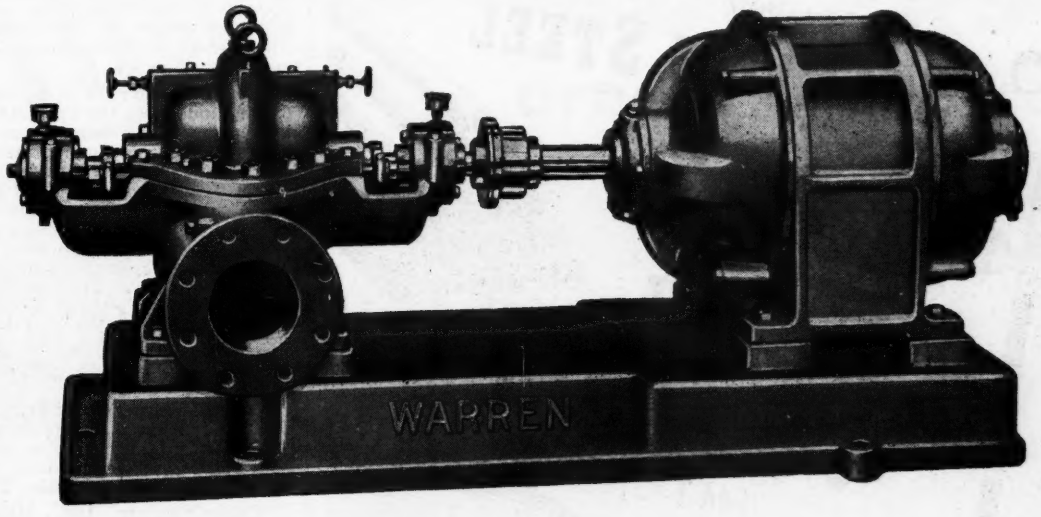
John H. Goss

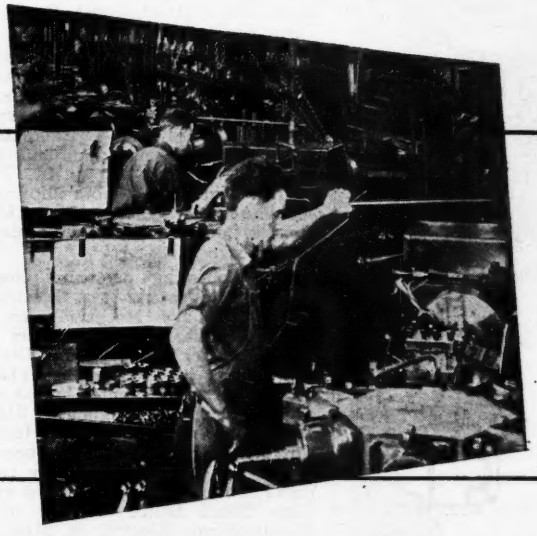
JOHN H. GOSS, retired president of the Scovill Manufacturing Co., Waterbury, Conn., died of a heart ailment on October 17. He was seventy-two years old.

Mr. Goss, who became chairman of the board when he resigned as Scovill president and general manager on September 22, celebrated his fiftieth anniversary with the company on September 12. His father, the late Chauncey Porter Goss, was president of the concern from 1900 until 1918. It is now headed by Leavenworth P. Sperry.

After graduating in 1894 from Yale, Mr. Goss, a native of Waterbury, went to work in the button department of the Scovill plant. In 1914 he became vice-president of the Connecticut Association of Manufacturers, and held that office until 1941, when he succeeded to the presidency upon the death of E. Kent Hubbard.

Here's A High Speed
WARREN PUMP
That Is Well Worth Looking Into Now





The boys in the Warren Acme Lathe Department like *all* Warren employees, are proud of our Army-Navy "E" Award . . . proud of the star recently added for continued production efforts.

Since more and more Warren Pumps are now being made available for commercial purposes, a timely tip is to look into Warren Pumps for your own future use.

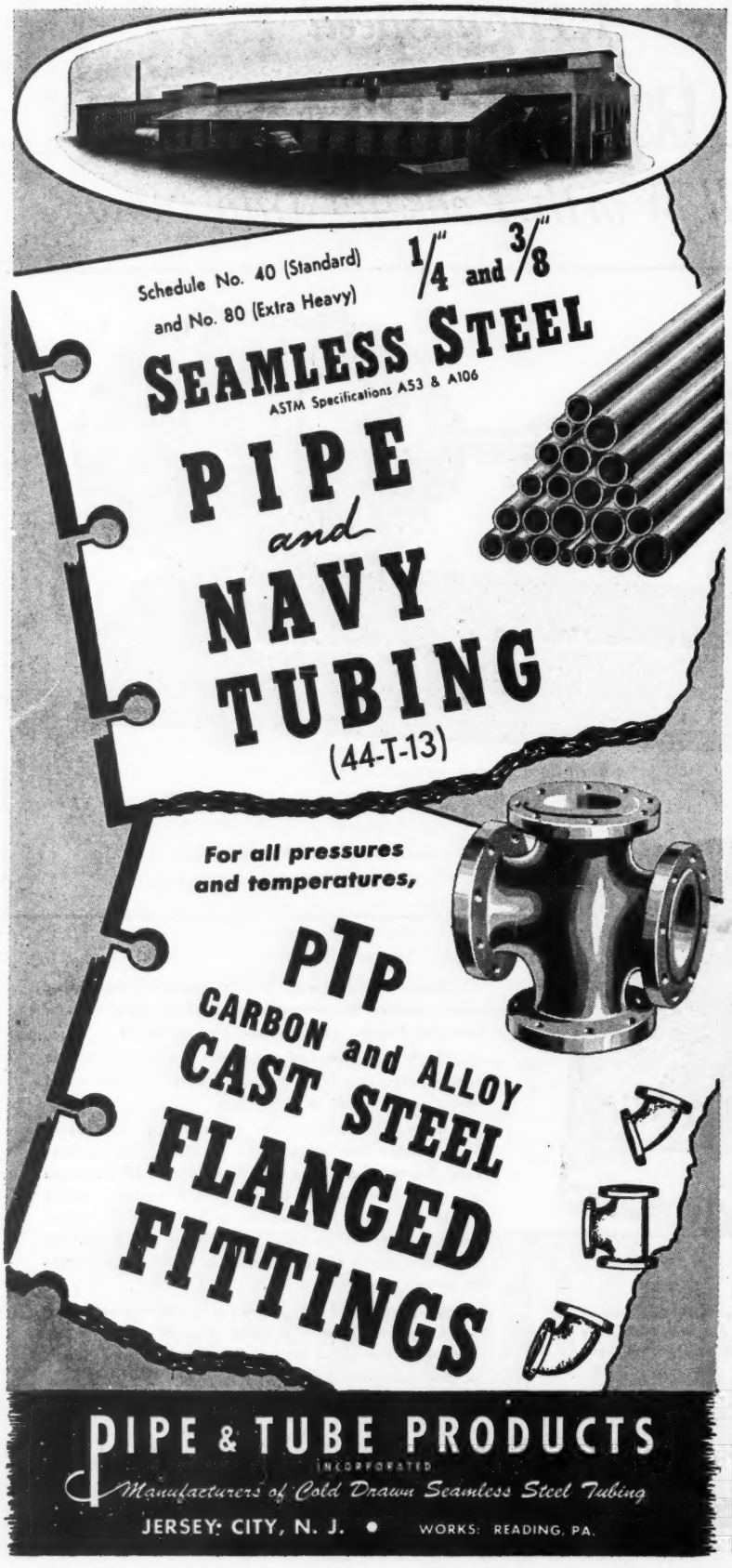
The Warren Pump featured here is a single stage double suction pump, type DBH, specially designed for high speed operation and heads up to 300 feet.

Its *impeller* is accurately machined and balanced to insure freedom from vibration . . . with all water passages hand finished. Case *rings* are of cast bronze of the nozzle type with joint between case rings and impeller forming a labyrinth seal . . . securely held in place by tongue and groove lock in the lower half of pump casing. *Bearings* are of ball type held against pump shaft shoulder by means of locknuts and washers.

Every Warren Pump is given a complete running test and all guarantees verified before shipment. Write for further information about Warren Pumps as they would apply to your particular problems.

ARMY E NAVY

WARREN STEAM PUMP CO., INC.
WARREN, MASSACHUSETTS



MANUFACTURERS' NEWS

S. M. Rust, retiring president of The Rust Engineering Co., has been elected chairman of the Company's board of directors; and S. M. Rust, Jr., who has been serving as executive vice president, has been elected president of the company. Mr. Rust, Sr., founded the company in 1905 with his brothers, E. M. Rust and the late E. J. Lee Rust, engaging in engineering design and construction of complete industrial plants and facilities. The company maintains offices at Pittsburgh, Pa., Birmingham, Ala., Washington, D. C., and New York, N. Y.

Young Radiator Co. of Racine, Wisconsin, announces the appointment of the Rodgers Engineering Co. of Dallas as sales and engineering representatives in northeast and north-central Texas. Rodgers Engineering Co. will provide sales and engineering service on the line of Young heating, cooling and air conditioning products as well as a complete line of complimentary accessories. The Happy Co. of Tulsa, Okla., with branch offices throughout Texas, Mid-Continent and Illinois oil fields, will continue to distribute Young products for producing, refining and pipe line application.

Yarnall-Waring Co. of Philadelphia, Pa., has announced the appointment of S. R. Edwards in charge of the company's new southwestern sales office at 805 Texas Bank Bldg., Dallas, Texas.

Cutler-Hammer, Inc., Milwaukee, Wis., has opened a sales office at 108 North Main Street, South Bend, Ind. Terry Fisher will be in charge.

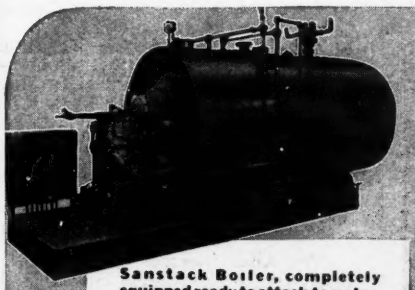
M. H. Detrick Company's attractive advertisement dealing with Detrick Burner Rings and their life in service appeared on page 195 of the November issue of POWER PLANT ENGINEERING. Inadvertently the name and address of the manufacturer was omitted. Those interested in getting more information should address their requests to M. H. Detrick Company, 111 W. Washington St., Chicago 2, Ill.

The following personnel changes made by Westinghouse Electric & Mfg. Co. have recently been announced: Charles G. Lammers was made manager of the Indiana Division with offices in Indianapolis; Thomas W. Cunnea was appointed branch manager of the Westinghouse Electric Supply Co. with offices in Houston, Texas; and H. E. Grout has been assigned the entire responsibility for all Small Motor factory operations at the Lima Small Motor Division of the Westinghouse Electric & Mfg. Co., which includes the Production Planning Department, Inspection, Test and Test Equipment Department, not previously under his jurisdiction.

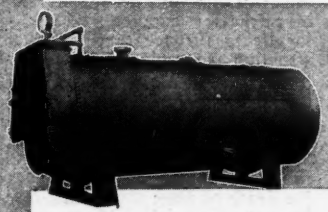
The Briggs Clarifier Co. has made two recent distributor appointments: The M. N. Dannenbaum Co., 2409 Wayside Drive, Houston 12, Texas, whose territory will be East Texas and the Gulf Coast; and McGregor & Werner, Inc., 1411 20th Street N.W., Washington, D. C., whose territory will be Maryland, Delaware and the District of Columbia.

Wherever Dependable Heating or Power is needed

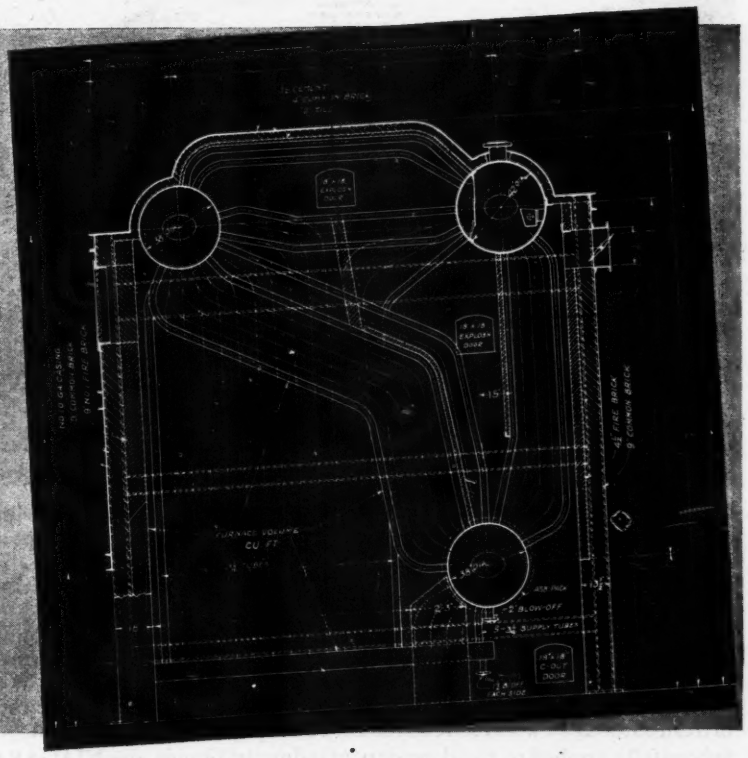
TITUSVILLE BOILERS are first choice



Sanstack Boiler, completely equipped ready to attach to water oil and electric lines. Available from 50 to 500 H.P., 125 pound to any desired working pressure.



TITUSVILLE power and heating units, designed and fabricated to specific pressures, temperatures and types of service.



Titusville designs and builds ALL types of Power and Heating Boilers to fit specific job requirements These modern boilers embody the many new manufacturing and material developments that make for maximum efficiency, dependable ruggedness and lower operating costs.

Titusville boiler engineers are available anytime, anywhere to aid in solving your boiler requirements

FABRICATED TO ALL BOILER CODE SPECIFICATIONS

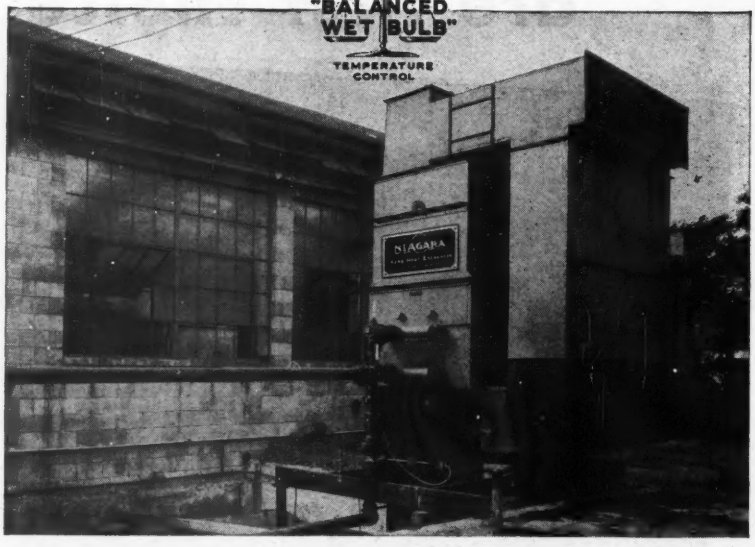
STRUTHERS WELLS CORPORATION
TITUSVILLE BOILER DIVISION
PLANTS AT TITUSVILLE, PA. AND WARREN, PA.
Offices in Principal Cities

COOL WATER, OILS AND SOLUTIONS OR AIR AND GASES... OR CONDENSE STEAM AND VAPOR

WITH THE *Niagara Aero* HEAT EXCHANGER

With "BALANCED WET BULB" TEMPERATURE CONTROL

U. S. Patent Re-issue No. 22,533



● This new method offers the advantage of lower cost thru the saving of 95% of cooling water. It avoids the risk of shut-downs from interrupted water supply. It provides a closed circuit saving the expense of water treatment. It saves the installation cost of water pumps, piping and extra equipment.

In addition, it offers precise temperature control, both during cooling operation and in bringing cooled liquids back to desired temperatures after shut-downs. This is accomplished with the Niagara "Balanced Wet Bulb" temperature control which always provides the correct admixture of fresh outdoor air with recirculated air. Full capacity is always maintained.

Successfully applied to a wide variety of industrial liquids, the NIAGARA Aero HEAT EXCHANGER has a three-year record of trouble-free operation in many important plants.

Write for Bulletin 96

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

DEPT. PP-124, 6 E. 45th St. NEW YORK 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Production of ammonia from a new plant at Lake Charles, La., is announced by The Mathieson Alkali Works (Inc.), 60 East 42nd St., New York 17, N. Y. The plant is one of the two largest in the country producing ammonia from natural gas. The new plant, built by the Defense Plant Corp. and operated under lease by Mathieson, is fully engaged in war production, the ammonia being used to produce high explosives. After the war, the corporation is expected to manufacture chemical fertilizers for Southern farmers and anhydrous ammonia for refrigeration.

Three appointments to executive positions in the sales and advertising departments of The Philip Carey Mfg. Co., producers of building materials and industrial products, have been announced. The appointments are: Harold D. Bates, advertising and sales promotion manager; Chester L. Owens, assistant general sales manager; and George B. Johnston, general merchandising manager. All three men will make their headquarters at the company's Cincinnati office.

The J. O. Ross Engineering Corp. of New York has announced the opening of a new branch office at 79 Milk St., Boston 9, Mass. The Boston office is to be in charge of Frank W. Partsch, vice president.

MANUFACTURERS' PERSONALS

The Atlas Lumnite Cement Co., a subsidiary of the United States Steel Corp., has announced the appointment of Roy T. Giles, Service Director, as Sales Manager. Mr. Giles has spent much of his time in the development of refractory concrete, which is used for lining furnaces and in other construction exposed to high temperatures.

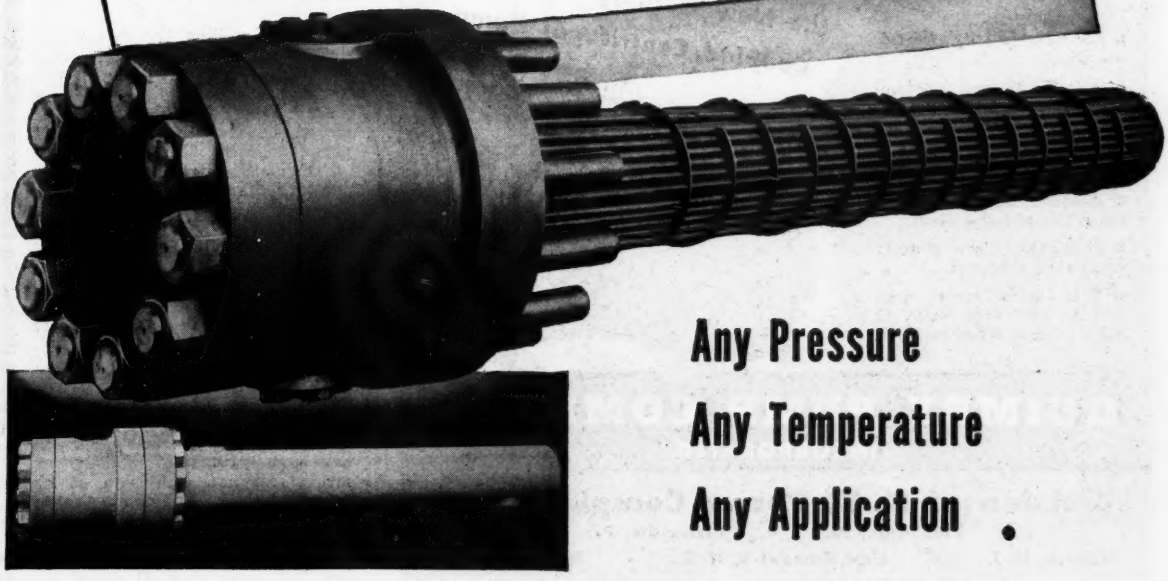
Robert R. Cole, vice president of the Monsanto Chemical Co. and general manager of the phosphate division, has recently been elected a member of the Board of Directors. He fills the place on the board left vacant by the death of John C. Brooks. Mr. Cole became an official of Monsanto in 1935 when the company acquired the Swann Chemical Corp., of which he was general superintendent.

Announcement has recently been made by Allis-Chalmers Mfg. Co. that Frank C. Angle has been appointed manager of all the company's field sales offices of the general machinery division and their operations. He will continue to supervise operations of the Pacific Region.

B. M. Brown has recently been appointed by the Westinghouse Electric & Mfg. Co. as manager of the Petroleum and Chemical Section. Mr. Brown succeeds Q. M. Crater, who was transferred to the Detroit, Mich., office of the Industrial Department as assistant manager.

John Thomas Gillespie, Jr., has been appointed Manager of Export Sales by the Watson-Stillman Co., Roselle, N. J. During the past 2½ yr, Mr. Gillespie has been with the Shipbuilding Division of W.P.B. as Chief of Staff Branch, and previously with the OPM Contract Distribution Division as Chief, Liaison Section with U. S. Maritime Commission, on a leave of absence from the Air Reduction Co., Inc., New York City.

SOUNDLY BASED DESIGN



Any Pressure
Any Temperature
Any Application

LUMMUS POWER PLANT EQUIPMENT

SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
•
STEAM JET AIR EJECTORS
•
BLEEDER HEATERS
•
BOILER BLOWDOWN HEAT EXCHANGERS
•
EVAPORATORS
•
FUEL OIL HEATERS
•
LUBRICATING OIL COOLERS

Another high pressure heat exchanger designed and fabricated by Lummus for a specific installation is illustrated above. This gas-to-gas unit is now giving trouble-free operation while maintaining full performance requirements at maximum loads.

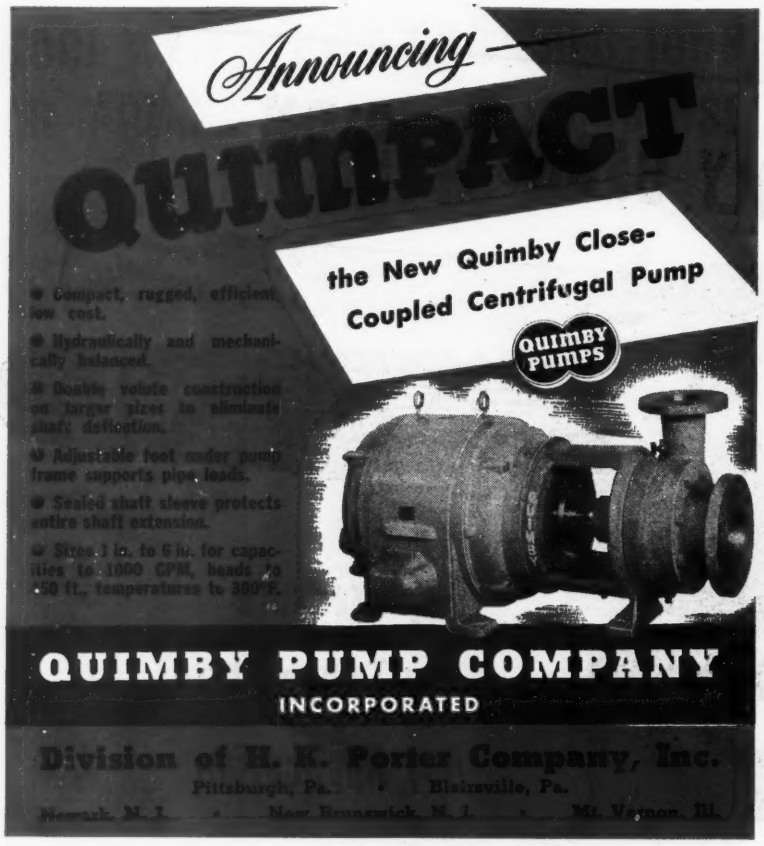
Designed for a major salt manufacturing company, the basic problem called for a 2,500 psi working pressure on both the shell and tube sides. The soundly engineered Lummus solution was a forged steel shell, channel and cover construction with the tube sheet integral with the channel. The unit was tested at 5,000 psi before installation.

Lummus engineering service is always available for the study of specific heat exchanger problems and the modernization of power plants to meet post war requirements. For further information write to:

THE LUMMUS COMPANY · 420 LEXINGTON AVE., NEW YORK 17, N.Y.

LUMMUS

HEAT EXCHANGERS


Announcing
QUIMPACT
the New Quimby Close-Coupled Centrifugal Pump
QUIMBY PUMPS
QUIMBY PUMP COMPANY
INCORPORATED
Division of H. K. Porter Company, Inc.
Pittsburgh, Pa. • Blairsville, Pa.
Newark, N. J. • New Brunswick, N. J. • Mt. Vernon, Ill.

Jacket Cooling Water Problems
respond to
HAERING
GLUCOSATES
Compressors
Gas, Air or Products Pipe Line
DIESELS
Locomotive or Stationary
Write for latest "H-O-H Lighthouse" containing articles on Diesel Engine Cooling Water Treatment and Scale and Corrosion Control in Engine Jacket Cooling Systems.
WE READ WATER
D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Illinois

Frederick K. Krell has been appointed by Globe Steel Tubes Co., Milwaukee 4, Wis., to serve as Advertising Manager with headquarters in the General Sales Department at Milwaukee. Mr. Krell is the immediate past president of the Milwaukee Junior Chamber of Commerce; at present he is Chairman of the Trade Promotion Committee of the U. S. Junior Chamber of Commerce and State Director of the Wisconsin Junior Chamber of Commerce.

M. J. Sandling has recently joined the Reliance Electric & Engineering Co. as sales representative in western Michigan, with headquarters in Kalamazoo. Mr. Sandling was formerly vice president and sales manager of the Howell Electric Motors Co.

David W. Choate has recently been named industrial manager at Atlanta, Ga., for the Minneapolis-Honeywell Regulator Co.; and W. S. Robards has been named industrial sales engineer of the Milwaukee branch of Brown Instrument Co. to succeed Mr. Choate.

Victor Failmezger, previously application and field engineer for H. K. Porter Co., Inc., of Pittsburgh, Pa., has been appointed to the position of sales manager of its subsidiary, Quimby Pump Co., of Newark and New Brunswick, N. J.

Appointment of Herman A. Everlien as general sales manager of the mechanical goods division of United States Rubber Co., and Walter F. Spoerl as merchandise manager, has recently been announced. Both positions are newly created. Mr. Everlien has had more than 41 years' experience in the mechanical rubber goods industry, Mr. Spoerl 36 years. Both men began their rubber careers at early ages as clerks in the sales department of the old Revere Rubber Co. in Chicago, later consolidated into the United States Rubber organization.

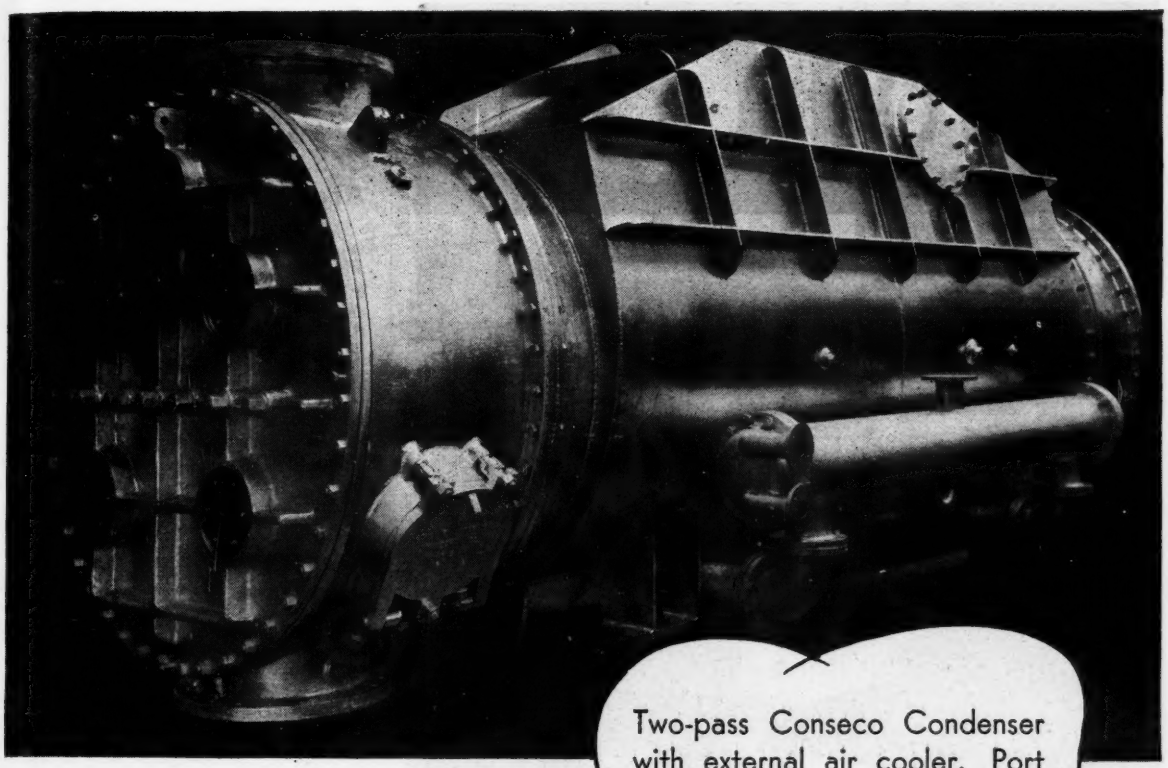
R. W. Owens has been elected vice president in charge of manufacturing at Elliott Co., Jeannette, Pa. Mr. Owens joined Elliott Co. as assistant to the president in February, 1944.

The appointment of Frank H. Stohr as assistant to the president of Elliott Co., Jeannette, Pa., has been announced. Mr. Stohr comes to Elliott from the Westinghouse Electric & Mfg. Co. with whom he has been associated since 1922.

Paul E. Bradfield, since 1923 a Pacific Coast Mechanical Engineer specializing in power piping, has joined F. J. Hearty & Co., California representative of The Edward Valve & Mfg. Co., Inc. Mr. Bradfield has been engaged in the public utility, consulting engineering and valve fittings fields. His association with F. J. Hearty & Co. began in October, 1944.

The appointment of A. J. Schmitz as Pacific regional manager was recently announced by Allis-Chalmers Mfg. Co. Previous to his appointment, Schmitz was manager of the company's Seattle office, and prior to that, manager of the Portland office. He has been with the company since 1914.

Felix N. Williams, General Manager of Monsanto Chemical Company's Plastics Division at Springfield, Mass., has been elected a vice president of the company. Mr. Williams has been associated with Monsanto for the past 20 years.



Two-pass Conseco Condenser with external air cooler. Port glasses and light in water box permit instant location of leaking tubes.

CONSECO

He is truly wise who profits from another's mishaps

Our broad experience servicing, repairing, rebuilding and replacing thousands of foreign and domestic condensers of all makes, gives us a practical background for designing efficient, economical condensers for any requirement. Every detail in a Conseco Condenser is designed to profit from good and bad features uncovered in the crucible of actual service.

There is no wasteful designing in Conseco Condensers. Materials selected for each part are the most economical for the expected life of the unit in the service for which it is designed.

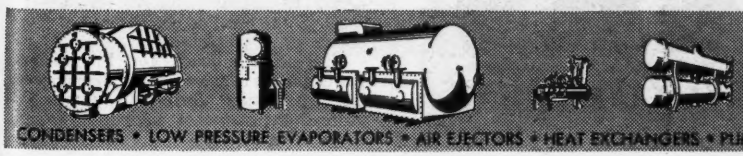
Our engineers will gladly give you the benefit of their extensive experience in the production of an efficient, economical, trouble-free condenser for your particular requirement. And, if you are in a hurry, name your own delivery date.

SERVICE

A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.

CONDENSER SERVICE & ENGINEERING CO., INC.

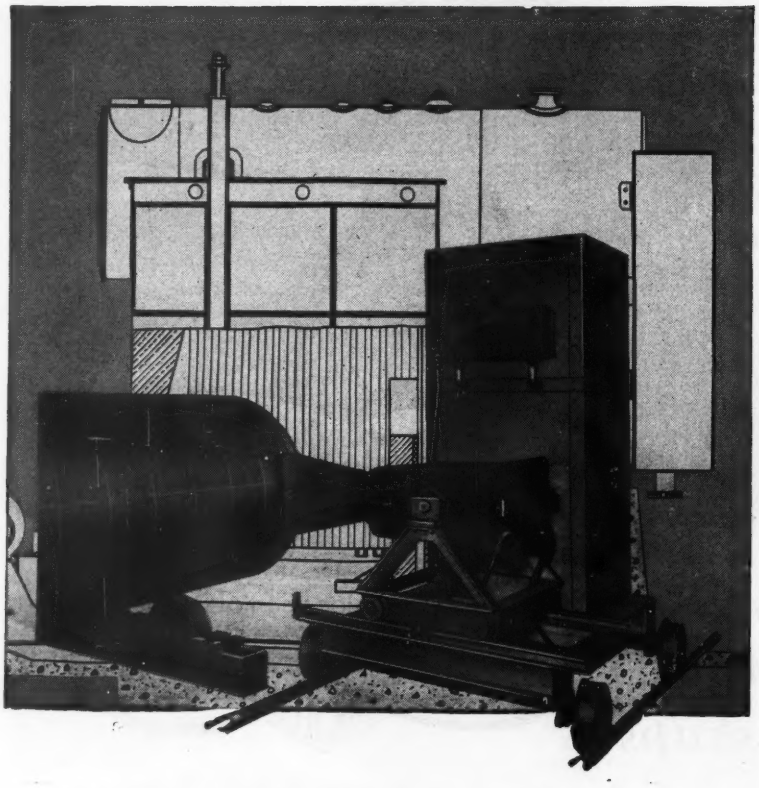
83 RIVER STREET, HOBOKEN, N. J. **Phone HOboken 3-4425** **After 6 P.M. or Sundays HOboken 3-4428**



CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS

UNION



COUNT UNION as a reliable source for pressure vessels and fabricated steel built to your specifications. Illustrated above is one method of inspection—the X-Ray. Magnaflux inspection is regularly used complementing X-Ray or Gamma Ray inspection as a further check on either of these methods. Union is prepared to meet any specified inspection routine that your service demands. Write for Booklet 117 to get better acquainted with Union's enlarged facilities. Send us your inquiry.

UNION IRON WORKS ★ ERIE, PA ★

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

NEWS FROM THE FIELD

U. S. Rubber Acquires Gilmer Co.

UNITED STATES RUBBER Co. has entered into negotiations for the assets and business of the L. H. Gilmer Co. of Philadelphia. Founded in 1907 and employing approximately 600 people, Gilmer lists among its chief articles of manufacture besides V-belts such products as automobile fan belts, rubber covered rolls and industrial truck wheels and other related items. No change in the management or operations of the Gilmer Co. is contemplated, John S. Krauss, president, will continue in the active management of this business.

Monsanto to Build Ordnance Plant

MONSANTO CHEMICAL Co., St. Louis, Mo., has been authorized by the Ordnance Department of the U. S. Army to design, build and operate a facility for production of a new ordnance development.

Cost of the new plant will be about $8,000,000. It will adjoin the Longhorn Ordnance Works, which Monsanto operates for Army Ordnance at Karnack, Texas. The first unit will occupy about 2000 acres. The construction program is scheduled to start almost immediately, with several thousand workmen being employed. When in operation the new plant will have a personnel of about 700.

E.C.P.D. Elects Officers

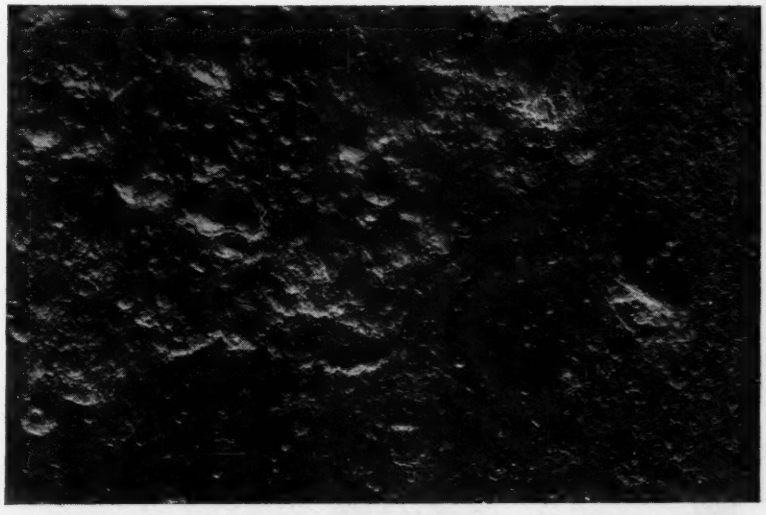
AT THE 1944 Annual Meeting of the Engineers' Council for Professional Development, which was held in the Engineering Societies Building, New York, N. Y., on October 20 and 21, E. S. Lee, engineer of The General Engineering Laboratory, General Electric Co., Schenectady, N. Y., was reelected chairman and James W. Parker, president, general manager, and director, The Detroit Edison Co., Detroit, Mich., was reelected vice-chairman. R. L. Sackett, assistant to the Secretary, ASME, New York, and George T. Seabury, Secretary ASCE, were elected secretary and assistant secretary, respectively.

For chairmen of ECPD committees the following elections were announced: Committee on Student Selection and Guidance, A. R. Cullimore, president, Newark College of Engineering; Committee on Engineering Schools, D. B. Prentice, president, Rose Polytechnic Institute; Committee on Professional Training, C. A. Pohl, consulting engineer, New York; Committee on Professional Recognition, N. W. Dougherty, dean of engineering, University of Tennessee.

Engineers' Council for Professional Development is a conference of engineering organizations, formed to enhance the professional status of engineers through cooperative effort.

Fight The Scourge Of Boiler Metal With APEXIOR

APEXIOR provides an impenetrable barrier against corrosion that frequently leads to inefficient operation — costly shutdowns — wasted manpower and horsepower.



Boilers and other equipment exposed to contact with hot water and steam at high temperatures are being effectively protected from premature old age by applications of APEXIOR NUMBER 1. Even some boilers on the inactive list have been returned to service with the help of this thoroughly tested protective coating. In all cases, APEXIOR has extended the period between cleanings and made cleaning much easier and quicker.

APEXIOR—THE PAINT THAT TAKES THE WEAR

APEXIOR NUMBER 1 is a chemically inert "film of safety" for boiler tubes, drums, economizers, and steam turbines. Brush-applied, it fills in the metal pores and joints shutting out water completely. There is less adherent scale, so the problem of scale removal is simplified.

APEXIOR'S tough, smooth surface — not the metal — takes the wear. One application lasts 2 to 3 years or more. It is easily renewed.

Painting boiler metal with APEXIOR is recommended by boiler insurance companies. And many manufacturers of turbines coat shafts, rotor bodies, and frequently interiors of casings with APEXIOR before shipping to customers.

Hundreds of industrial power plants, utilities, railroads, and marine operators have relied on APEXIOR to aid them in fighting the scourge of boiler and turbine metals. It is helping them through this critical period in their history. APEXIOR can do likewise for you . . . prolong the life of your boilers or any equipment having hot wet surfaces . . . conserve manpower and vital materials . . . see you through the war period.

Here are some of the many companies now benefitting by APEXIOR

Hercules Powder Co.
Narragansett Electric Co.
Westinghouse Electric & Mfg. Co.
American Sugar Refining Co.
Tennessee Eastman Corp.
The Pullman Co.
Duke Power Company
Ford Motor Co.
Pittsburgh Plate Glass Co.
Pennsylvania Railroad Co.
General Aniline Works
Standard Oil Co. of Indiana

See how easily APEXIOR can be applied

Write today for Bulletin 1290 (Industrial) or 1305 (Marine) giving complete details on peak protection for peak production.

APEXIOR

A Peacetime Plus ★ ★ ★ A Wartime Must

RECOMMENDED BY ALL U. S. AND CANADIAN BOILER INSURANCE COMPANIES

The **DAMPNEY COMPANY of America**

protective coatings for

STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

THE DAMPNEY COMPANY OF AMERICA
Hyde Park 36, Mass.

Please send free Bulletin 1290 (Industrial) ☐ 1305 (Marine) ☐

Name.....

Company.....

Address.....

Main Office: **HYDE PARK • BOSTON 36, MASS.** • *Branch Offices:* **ATLANTA • CHICAGO • NEW YORK • DETROIT • PHILADELPHIA**

Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Honolulu, T. H., Marine Dept., 115 Liberty Street, New York, N. Y.

Ebasco Services, Inc.

FOR MANY YEARS, Ebasco Services, Inc., a wholly owned subsidiary of Electric Bond and Share Co., has designed and constructed steam and hydroelectric power stations, gas plants and electric and gas transmission systems for the various operating companies associated with Electric Bond and Share. Ebasco Services is not only continuing its wide range of engineering and construction services to utility companies, but during the past two years has extended the scope of those services to include the industrial and commercial field. The list of industrial clients is reported to be expanding rapidly.

Ebasco believes that the engineering experience and methods applied to utility work by its technical, research and operating staff of about 600 people can be of equal value in solving other types of industrial and commercial problems. For example, one of its present undertakings is an analysis and outline for reorganization of certain distribution facilities of a large commercial firm; this study is not concerned in any way with generation or distribution of electric power. In short, the consulting service is now available on industrial and commercial problems generally.

The Ebasco Services program of design and construction, in the recent past and at present, includes about 400,000 kw of electric generating capacity, bringing its accumulated total of work, as of 1944, to over 1,800,000 kw of thermal-station capacity and about 800,000 kw in hydroelectric plants. This work includes many well-known steam and hydraulic stations, most of which have previously been described in POWER PLANT ENGINEERING and other technical periodicals.

Standard Oil Changes President

EFFECTIVE January 1, 1945, Edward G. Seubert will retire from the presidency of Standard Oil Co. of Indiana, after serving his company more than fifty-two years and heading it as chief executive more than fifteen. He will remain a director and become chairman of the executive committee of the board. Robert E. Wilson, new president of Pan American Petroleum and Transport Co., will become chairman of the board and chief executive officer of the Indiana company.

A. W. Peake, at present a vice president, will advance to the office of president. His place will be filled by F. O. Prior, now president of Stanolind Oil and Gas Co., an oil producing subsidiary. Mr. Prior will be a director and vice president of the Indiana company and will also be chairman of the board of the Stanolind Oil and Gas Co., Stanolind Pipe Line Co., and Stanolind Oil Purchasing Co. as Mr. Peake has been. Mr. Wilson will take over Mr. Seubert's responsibilities as chairman of the board of Pan American Petroleum and Transport Co., Standard's eastern subsidiary.

New Officers for AWS

OFFICERS of the American Welding Society who were installed at the Annual Meeting held in Cleveland, Ohio, are: President—A. C. Weigel, Vice President, Combustion Engineering Co., Inc., New York. First Vice President—Isaac Harter, Vice President, The Babcock & Wilcox Co., Barberton, Ohio. Second Vice President—Dr. W. F. Hess, Assistant Professor in Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y. Treasurer—O. B. J. Fraser, Director of Technical Service on Mill Products, International Nickel Co., New York. Secretary—M. M. Kelly, Society Headquarters.

Directors of the Society taking office are: Roger W. Clark, Welding Engineer, General Electric Co., Schenectady, N. Y.; L. W. Delhi, Vice President, Western Pipe & Steel Co., San Francisco, Cal.; J. F. Lincoln, President, Lincoln Electric Co., Cleveland, Ohio; and H. Malcolm Priest, Engineer of the Railroad Research Bureau, United States Steel Corp. Subsidiaries.

Los Angeles Department of Water and Power—Correction

ATTENTION has been called to a typographical error in the News Item under the above heading which appeared on page 154 of the September, 1944 issue. As published there is a misplaced decimal point in the figure for the firm rate of power. This should be 0.124 cent, instead of 0.00124 cent as it appeared in the item.

Trouble-shooting made easy when the new Wilson Check List is used. Available for the asking, this new bulletin contains information of value to the user of tube cleaners.

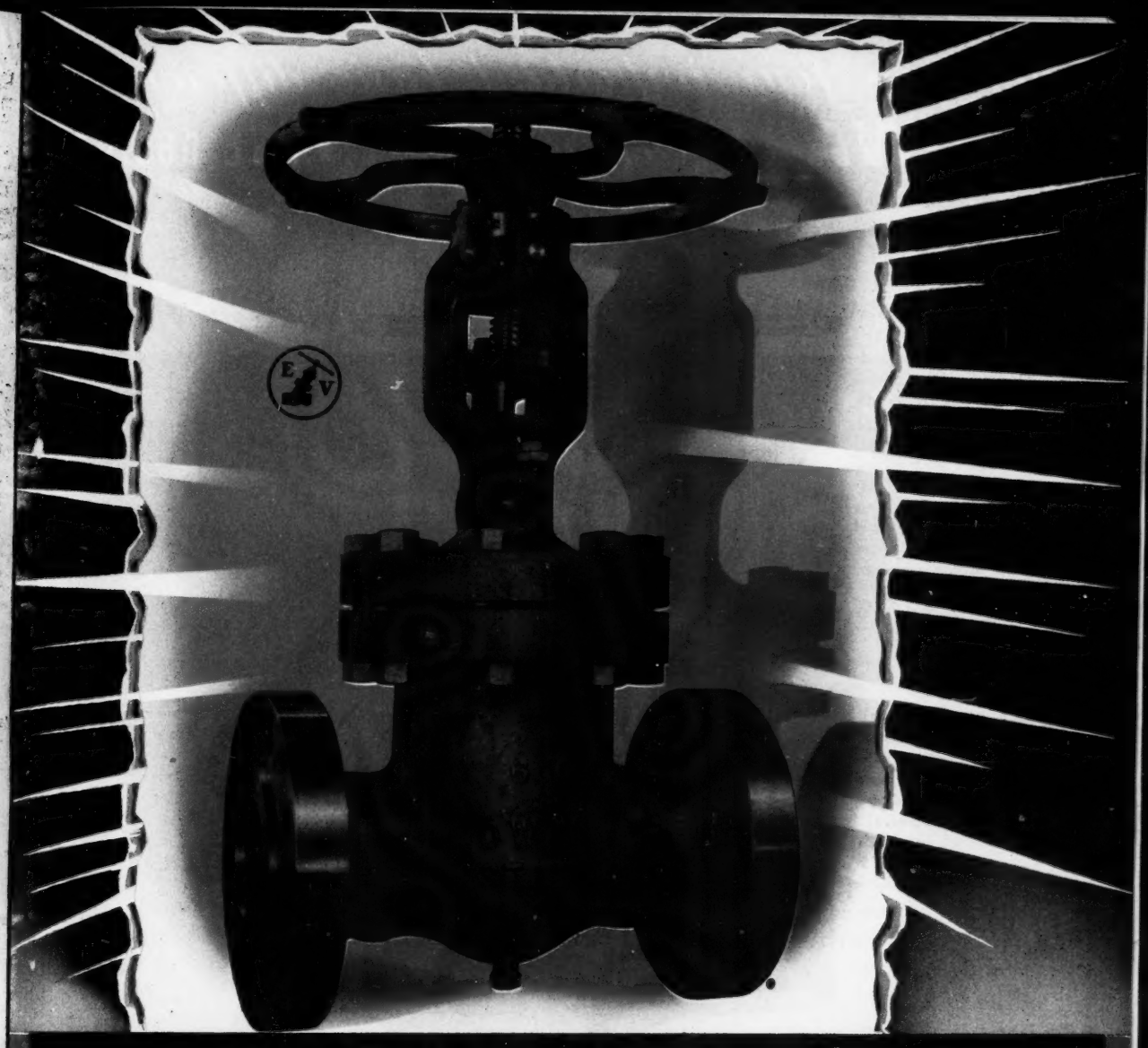
Among the valuable tube cleaning aids in the Check List are:

1. **A tube cleaner's check list—questions to ask yourself both before and after tube cleaning as well as while on the job—all help you reduce operating and maintenance expense and increase tube cleaning efficiency.**
2. **Tube cleaner selection guide—helps the engineer select the proper tube cleaning motor and cutter head for his particular fouled tube problems.**
3. **Table of tube cleaner sizes—helps you get prompt action on new and replacement orders for your Wilson Tube Cleaners.**
4. **A complete list of Thomas C. Wilson's representatives in all principal cities of the United States and Canada—to help you get better tube cleaner service, newest educational literature, etc., etc.**

MODERN TUBE-CLEANERS FOR THE PROBLEMS OF TODAY

wilson

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK



Basically different in design,

here is a GATE VALVE *with all*

working parts in correct alignment.

New by **EDWARD**

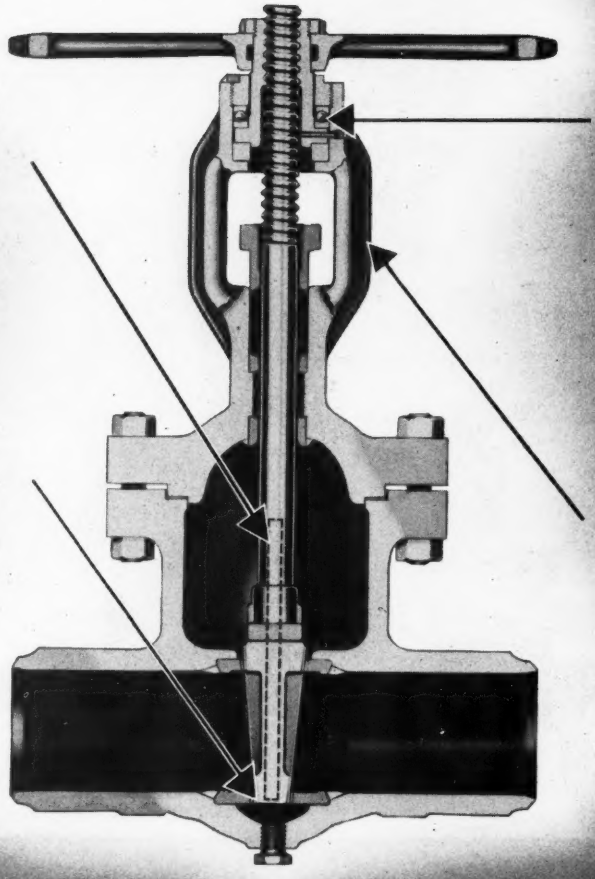
WRITE FOR CATALOG 12-E

THE EDWARD VALVE & MFG. CO.

Here are four important basic differences in **EDWARD** *cast steel* GATE VALVE design

1 Close fitting hardened wedge guides welded to body *after* seat rings and wedge are located. The result—perfect alignment of working parts and elimination of unnecessary wear-producing drag of wedge across seating faces in opening and closing valve under pressure.

2 Correctly positioned hard surfaced seats, integral with body, and hard faced wedges. Standard construction—*not a "special" which must be ordered.*



3 Simple yoke construction with ball bearing operation even in medium sizes. EValized surfaces where abrasion is a problem, and no superfluous parts.

4 One piece bonnet for absolute alignment, easy operation and minimized maintenance.

No wobbly wedges to cause excessive seating wear or slam against stem head when opened under pressure in Edward gate valves. In contrast with traditional gate valve design, guide ribs in Edward gate valves are accurately located with respect to seat faces and wedge, then welded integrally to body with continuous weld fillets. Clearances are thus cut to minimum and wedge can travel practically to closed position before seating faces touch.

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO INDIANA

If you use Prefabricated Piping, Pressure Vessels and Heat Exchangers

ALCO "Triple Service" can save you Time and Money

WHEN you buy prefabricated piping, pressure vessels, and heat exchangers from ALCO, you save time and money. Here's why:

1. PURCHASING WILL COST YOU LESS

If you buy these products from separate sources, your purchasing department will be compelled to deal with at least three companies; negotiations will be needlessly complicated, consume more time, cost you more money. But by letting ALCO supply your requirements for all of these products, you simplify purchasing, save time and expense.

2. ENGINEERING WILL COST YOU LESS

When you purchase prefabricated piping, pressure vessels, and heat exchangers from three or more different sources, your engineers are compelled to deal with each of the various engineering departments of all these suppliers. That means more time and money loss to your organization. This waste, too, can be saved when you deal with ALCO on all these counts.

3. INSPECTION WILL COST YOU LESS

If you buy prefabricated piping from one source, and pressure vessels and heat exchangers from others, you must send three inspectors to the three plants fabricating your equipment. ALCO "triple service" means all inspection can be handled by one inspector at our Dunkirk plant.

4. ACCOUNTING WILL COST YOU LESS

Finally, your accounting department has three separate accounts to handle—instead of one—if you deal with three suppliers of prefabricated piping, pressure vessels and heat exchangers, respectively; instead of leaving it all to ALCO.

• • •

ALCO's reputation for competence in designing, fabricating and delivering on time is beyond question. To rely on ALCO for prefabricated piping *and* pressure vessels *and* heat exchangers is good business for your company and will be thoroughly justified by *results*. We welcome the opportunity of demonstrating the advantages you gain by ALCO "triple service."

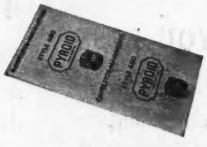
American Locomotive

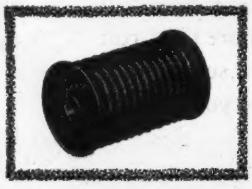
ALCO PRODUCTS DIVISION

Heat Exchangers • Pressure Vessels • Prefabricated Piping

30 Church Street, New York 8, N. Y. • Dunkirk, N. Y.

KEEP IT UNDER YOUR LID WITH R/M SHEET PACKINGS





Gaskets of R/M Sheet Packings for controlling oil, water, gas, grease, air, gasoline, etc., are doing double-duty these days. In fact, there are R/M Packings for every conceivable use keeping fluids flowing for vital industries. The economies they offer in many extra hours of service will soon be available to everyone. Be sure to include R/M Packings in your plans for low-cost, post-war production.

INDUSTRIAL SALES DIVISION

RAYBESTOS-MANHATTAN, INC.

MANHEIM, PENNSYLVANIA

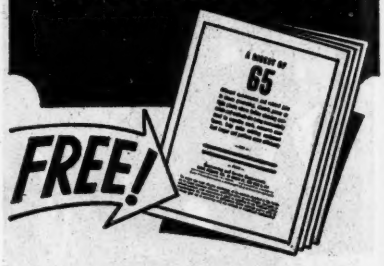
Bridgeport, Conn. ★ North Charleston, S. C. ★ Passaic, N. J.

MAKERS OF PACKINGS FOR EVERY INDUSTRIAL USE

Helps Plant Engineers Handle

POWER PLANT MAINTENANCE

Easier . . . Faster



FREE!

NEW OAKITE DIGEST Gives Data on *FAST* Cleaning Techniques!

How are other plant engineers solving today's problem in equipment maintenance? What short-cuts are they finding effective? What simplified procedures and materials are saving time and money?

You will find the answers to 65 different maintenance problems in this NEW, 16-page Oakite Maintenance Digest . . . cleaning, de-scaling and related techniques that will help you keep all your equipment at peak efficiency! With this invaluable information at your fingertips, you, too, can speed-up maintenance and shorten equipment down-time.

Your Copy FREE on Request!

Write NOW for your FREE copy of this practical guide to power plant maintenance . . . no obligation, of course!

OAKITE PRODUCTS, INC.
23A Thames Street, New York 6, N. Y.

Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE Buy Bonds for Victory
Specialized cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

"WHAT'S THE ANSWER IN DOLLARS and CENTS

...if we modernize our boiler plant now?"

YOU enjoy immediate savings in fuel consumption, plus a substantial step-up in steam production, when you modernize with TODD burners.

Hundreds of plants have already modernized costly, inefficient boiler plants with TODD oil and gas burning equipment. *They report fuel savings up to 10% and more, with corresponding power increases.*

Operating economies like these are not unusual. For the over-all efficiency of the modern TODD burner, reflecting 30 years of sound engineering achievement, means *steam production at minimum cost*—a dollars-and-cents reason why NOW IS THE TIME TO MODERNIZE WITH TODD.

TODD combustion engineers are specialists in the modernization of industrial and commercial boiler rooms of all types. Why not call on them today . . . for an impartial survey of *your* plant . . . for suggestions, specifications, estimates. Their services are available at any time, without obligation.

ARMY E NAVY

COMBUSTION EQUIPMENT DIVISION

TODD SHIPYARDS CORPORATION

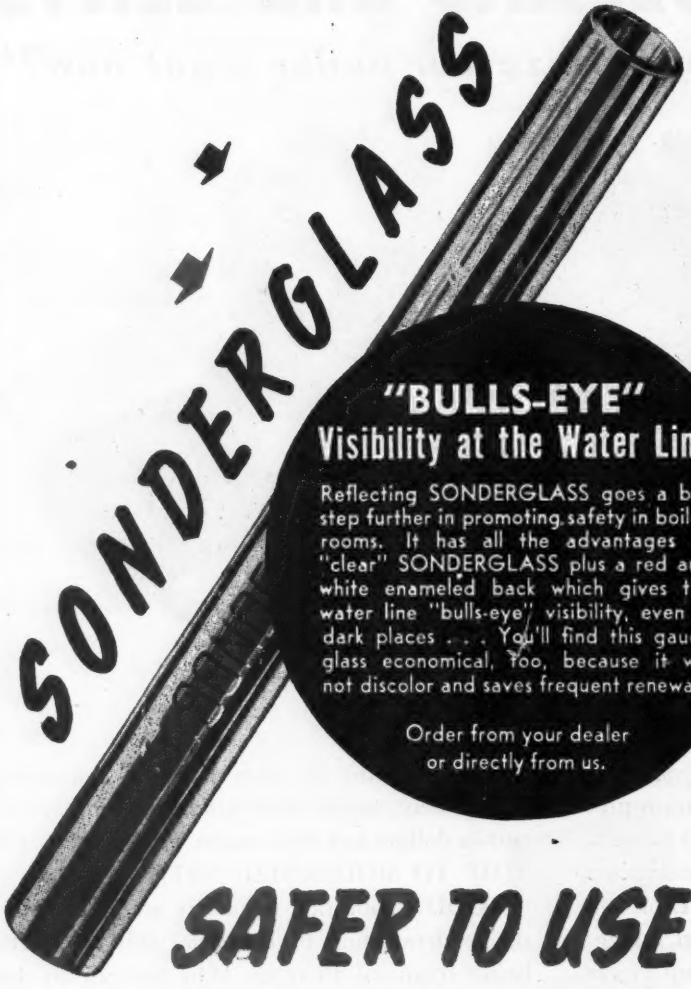
601 West 26th Street, New York 1, N. Y.

NEW YORK, BROOKLYN, ROCHESTER, HOBOKEN, NEWARK, BARBER, N. J., PHILADELPHIA, SO. PORTLAND, ME., BOSTON, SPRINGFIELD, MASS., BALTIMORE, WASHINGTON, CHICAGO, GRAND RAPIDS, TAMPA, GALVESTON, HOUSTON, MOBILE, NEW ORLEANS, LOS ANGELES, SAN FRANCISCO, SEATTLE, TACOMA, MONTREAL, TORONTO, BUENOS AIRES, LONDON

ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT

Specify the Boiler Gauge Glass That's

EASIER TO SEE



"BULLS-EYE" Visibility at the Water Line

Reflecting SONDERGLASS goes a big step further in promoting safety in boiler rooms. It has all the advantages of "clear" SONDERGLASS plus a red and white enameled back which gives the water line "bulls-eye" visibility, even in dark places . . . You'll find this gauge glass economical, too, because it will not discolor and saves frequent renewals.

Order from your dealer or directly from us.

SAFER TO USE

A. W. CHESTERTON CO., 64 India St., Boston, Mass.

Distributors in Principal Cities

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**

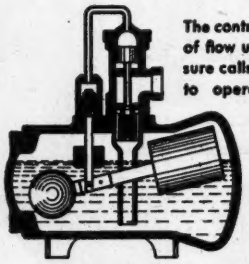
We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.

Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

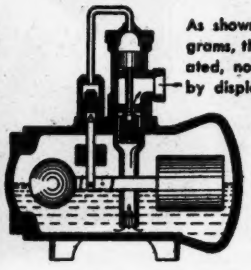
NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

How to Handle Condensate Drainage at High Pressures

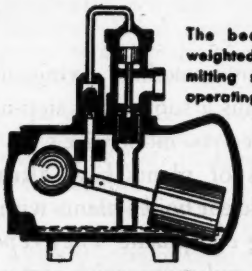


The control of a high rate of flow under high pressure calls for great force to operate the valve.

In the Cochrane Discharger this force is provided by a piston actuated by a pilot valve.



As shown in these diagrams, this pilot is operated, not by floats but by displacement bodies of different densities at either end of a beam which tilts with the rise and fall of the water level.



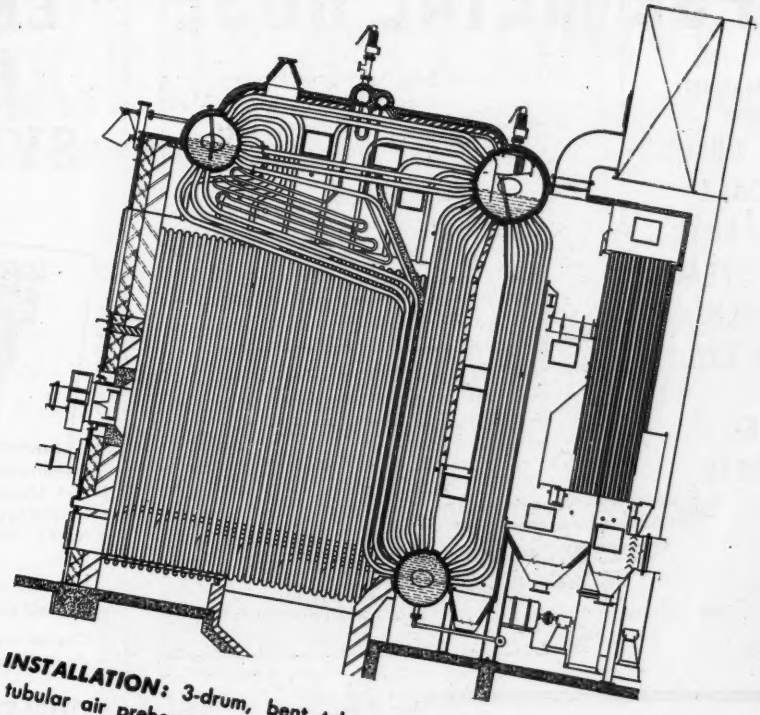
The beam opens the weighted pilot valve admitting steam to main operating valve which instantly opens main discharge valve to full opening, avoiding wire drawing or chatter.

Publication 2935 gives complete data.

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia, Pa.

COCHRANE
STEAM SPECIALTIES

EDGE MOOR WATER TUBE BOILERS



THIS INSTALLATION: 3-drum, bent tube, with superheater, water walls, tubular air preheater.

CAPACITY ..... 45,000 lbs. steam per hour
DRUM PRESSURE ..... 450 lbs.
DEGREES OF SUPERHEAT 200
FINAL STEAM TEMPERATURE ... 650° F.
This unit is fired with pulverized coal.

● Edge Moor Boilers are designed for any required capacity and up to 900 lbs. drum pressure. Complete steam generating units are available, including boilers, superheaters, water walls, economizers and air preheaters.

STEAM GENERATING EQUIPMENT

EDGE MOOR

BRANCH OFFICES: NEW YORK 20, N. Y.: 30 ROCKEFELLER PLAZA
CHICAGO 2, ILL.: ONE NORTH LA SALLE STREET

MAIN OFFICE: EDGE MOOR, DELAWARE

Use

ECLIPSE METAL HOSE

for
Low Cost Leakproof
Handling of
OILS • GASES
CHEMICALS
REFRIGERANTS
AIR • STEAM
HYDRAULIC
VACUUM, ETC.
Also
DIESEL
EXHAUSTS

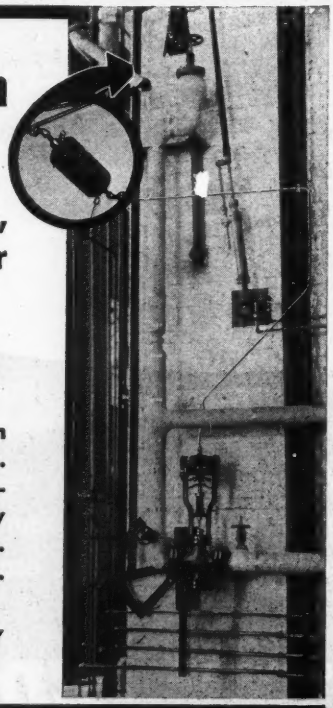
ITS deep, parallel sidewall corrugations combine maximum flexibility with lasting toughness—makes Eclipse Flexible Metal Hose the logical low-cost material for Diesel exhausts and for handling all kinds of liquids or gases where vibration and expansion are present . . . Eclipse Metal Hose withstands high pressure and temperatures. Monel hose is stocked in sizes ¼ in. to 2 in. I.D.; steel hose can be produced up to 40 in. I.D. Write us about your problems of conveying non-solids, non-abrasives. Ask for latest descriptive bulletin.

THE INVISIBLE CREW
Precision Equipment by Bendix AVIATION CORPORATION
Dept. 19—Phila. Div.—Philadelphia, Pa.

With No Drain on Power—

you can have safe, accurate Feed Water Regulation with

Swartwout



(1) Simplicity of construction avoids complicated adjustments. *(2)* Ruggedly built to operate under severe conditions: *(3)* Easily adjusted to varying conditions. *(4)* Easy to install on any boiler.

Write for Bulletin S-20-D.

THE SWARTWOUT COMPANY
18511 Euclid Ave. Cleveland 12, Ohio

Swartwout POWER PLANT EQUIPMENT

VIKING

ENGINE *ALARM* SYSTEMS

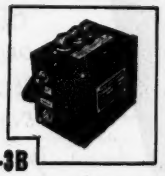
TYPE M
CONTACT MAKERS

Pressurestatic or Thermostatic Contact Makers for lubricating-oil or circulating-water systems for all types of stationary or mobile equipment.

Now available in sheet-steel housing to avoid critical materials.

Can be supplied with complete indicating system.

COMPLETE ALARM SYSTEM



TYPE M-3B

Complete alarm system consists of Type M-3B combination pressure control, junction box and visual indicator, together with Type M Thermostatic Contact Maker, and signal howler.

WATER- AND WEATHER-TIGHT

TYPE C
CONTACT MAKERS

Where Contact Maker is exposed or must be waterproof, Type C Pressurestatic or Thermostatic is recommended.

Manufacturers of engine alarm systems, annunciators, marine and industrial instruments. Write for specifications.

VIKING INSTRUMENTS, INC.
403 Fairfield Ave.,
Stamford, Conn. Telephone 4-7375

Efficient, High-Capacity Handling with LINK-BELT BELT CONVEYORS

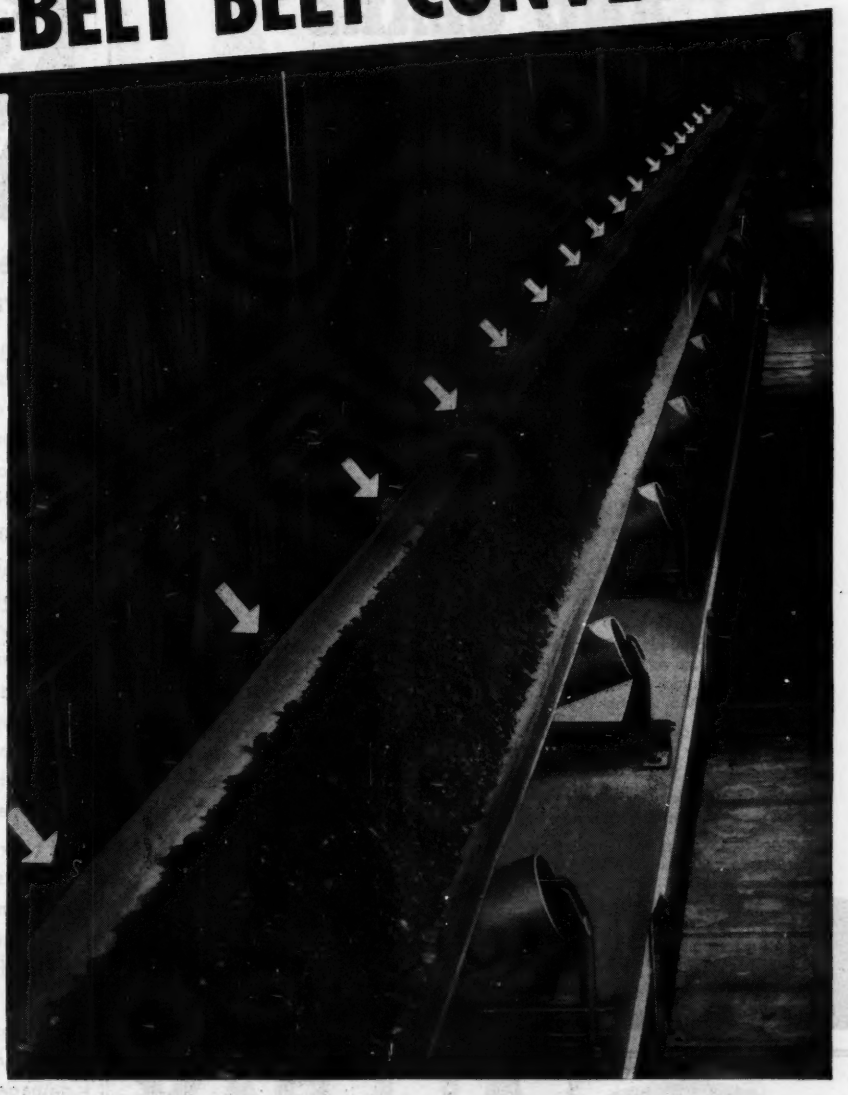
YOU can be assured of maximum belt life, minimum power and maintenance cost, and dependable trouble-free service with Link-Belt Anti-Friction Belt Conveyor Idlers and other equipment.

Link-Belt engineers pioneered in the development of anti-friction belt conveyor idlers and have consistently improved the original, fundamental design—the grease seal, bearing adjustment, shaft mounting and the supporting stands and brackets. All with the result that today's Link-Belt designs offer the very best in belt conveyor equipment to keep production "On the Move" for Victory.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Pittsburgh 19, Cleveland 13, Detroit 4, Toronto 8.

Offices in principal cities. 9724



Link-Belt 24" wide primary belt conveyor handling coal from crusher house to cross belt conveyor. Part of a complete Link-Belt coal handling system at Cedar Rapids Generating Station of Iowa Electric Light and Power Co.

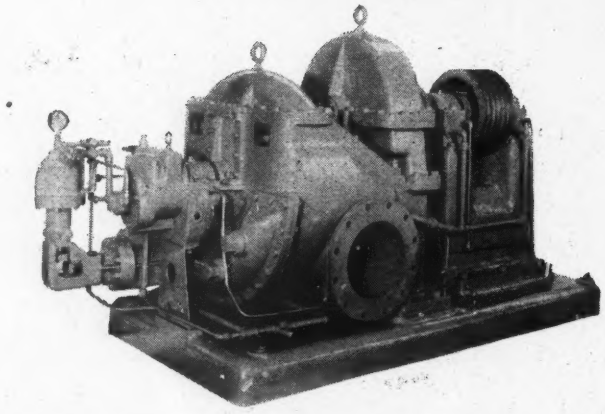
LINK-BELT

BELT CONVEYOR EQUIPMENT

IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • DRIVES

LINK-BELT EQUIPMENT: Conveyors of all types, such as belt, bucket, screw, flight, drag, chain, apron, etc. . . Bucket Carriers and Elevators . . Skip Hoists . . Feeders of all types . . Weigh Larries . . Coal Crushers . . Water-Intake Screens . . Rotary Railroad Car Dumpers . . Underfeed Screw Type Stokers . . Locomotive and Crawler Cranes . . Roto-Louvre Dryers and Coolers . . Car Spotters and Haulage Systems . . Portable Conveyors and Bucket Loaders . . Silent and Roller Chain Drives . . Speed Reducers . . Variable Speed Transmissions . . Chains and Attachments of all types (Malleable Iron, Promal and Steel) . . Sprockets . . Elevator Buckets . . Gears . . Clutches . . Couplings . . Base Plates . . Take-Ups . . "Friction Fighter" Self-Aligning Ball and Roller Bearing Units . . Babbitted Bearing Units . . Send for Catalogs.

MURRAY
STEAM TURBINES AND GEARS



In the smaller sizes, MURRAY recommends the use of the Type UG integral turbine-gear unit, for lowest steam consumption and moderate cost. Unless the slow speed apparatus to be driven is for standby operation only, the geared set will pay for itself in a short time.

Compare its steam rate with that obtained by using a direct connected turbine.

Correct alignment of the gear and turbine bearings is assured, and is easily maintained, since expansion of the exhaust casing is allowed by machined pads and bolts, located at the center-line, holding the turbine and gear casings, together with the sliding dowel, which allows expansion.

The pinion and turbine shaft are forged in one piece. The gear may be solid forged, or built-up, using a forged rim and cast center. Depending on face width, the gears are single or double helical.

The unit shown is equipped with direct-acting variable speed governor, and drives a reciprocating ammonia compressor in an eastern food processing plant.

For turbines from 10 horsepower to 2500 kilowatts rating—refer to our nearest representative.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

ALLPAX
THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

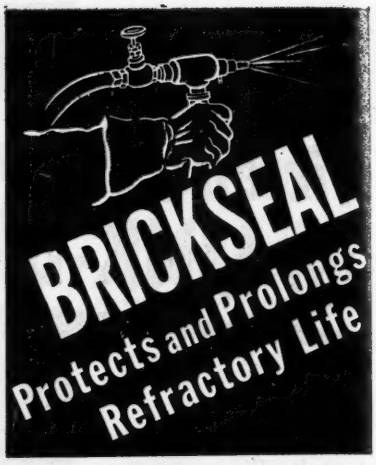
Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

THE ALLPAX CO., INC.
Mamaroneck, N. Y.

•

Distributors Everywhere



Applied like paint, prevents cracking and spalling

Now, more than ever, anything which prevents interruption of steam production is of vital importance. Brickseal refractory coating prolongs the life of new or old brickwork by preventing disintegration due to cracking, spalling and slagging.

Brickseal consists of high-fusion clays and metals combined in oil. Furnace heat drives off the oils and vitrifies the clays and metals, permanently binding the bricks with a highly-glazed, vitreous, monolithic coating, impervious to gases, carbon and air infiltration. The highly reflective surface keeps heat inside and increases boiler efficiency.

At operating temperature Brickseal becomes semi-plastic so that it expands and contracts with the wall, and therefore cannot crack, peel or blister due to sudden temperature variations. This feature also enables Brickseal to bind loose brickwork and old cracks. Slag and clinkers can be removed without damage to lining. Brickseal is applied easily with brush or spray gun, and the boiler may be fired at once. At very little cost, Brickseal will assure longer, uninterrupted production. Write for sample.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

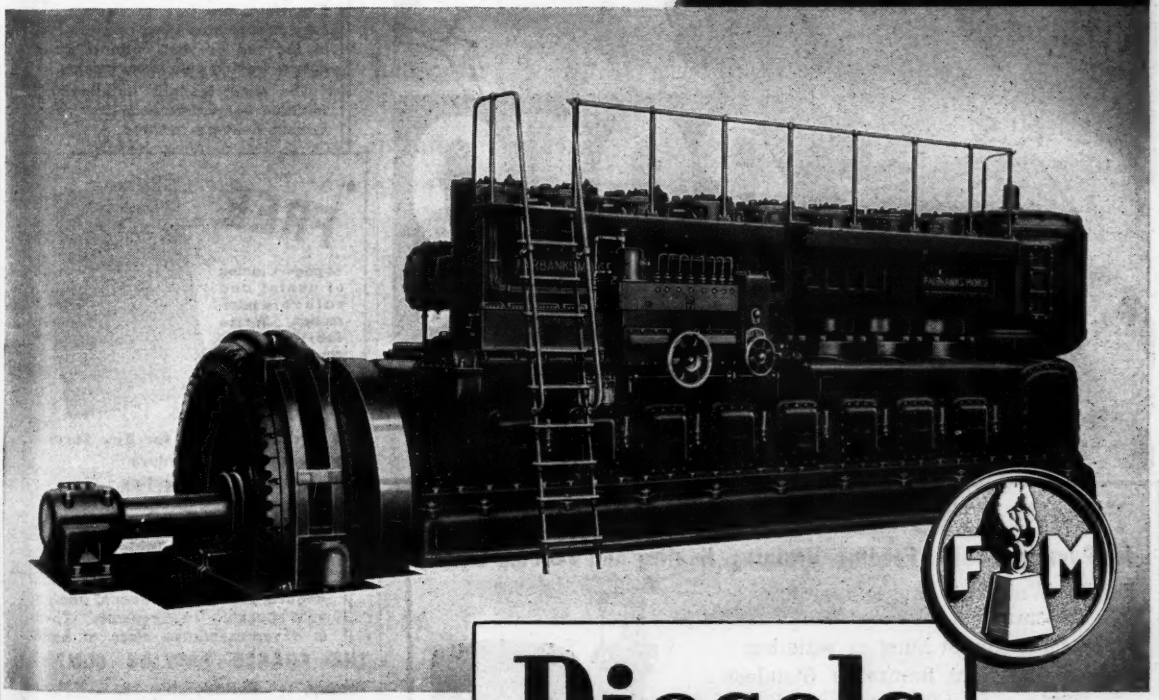
"A name worth remembering"

Fairbanks-Morse

To search constantly for ways to improve is a basic Fairbanks-Morse policy. Development work goes on continually in our research laboratories—in good years and bad, in time of peace and in time of war. During the months and years ahead this research will yield a rich harvest to users of Diesel engines and other industrial equipment.

R. A. Morse Jr.
General Sales Manager

In hundreds of power plants, this Fairbanks-Morse heavy-duty-Diesel has proved its dependability and economy.



Diesels

Fairbanks, Morse & Co.
Chicago 5, Illinois

Diesel Locomotives • Diesel Engines
Generators • Motors • Pumps • Scales
Magnetos • Stokers • Railroad Motor Cars
and Standpipes • Farm Equipment

BUY WAR BONDS AND KEEP 'EM

© 1944. Fairbanks, Morse & Co.

Long-distance control wastes time and labor in tube cleaning

Roto offers you operating control of tube cleaners where you need it most, right at the cleaner. An air valve, directly behind the Roto motor, permits the operator himself to turn air on and off instantly, eliminating the helper and saving time ordinarily lost by signalling. The advantages of Roto Tube Cleaners are particularly noticeable where a number of them are in simultaneous operation. Why not enjoy the time- and labor-saving features of Roto Tube Cleaners now, when you need them most?

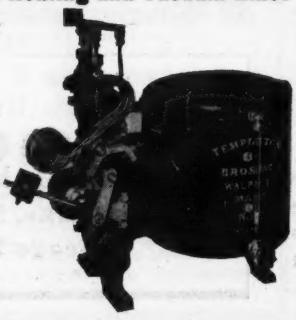
ROTO TUBE CLEANERS

The ROTO Company
145 Sussex Ave., Newark 1, N. J.
A Division of Elliott Company

TEMPLETON RETURN STEAM TRAPS

for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

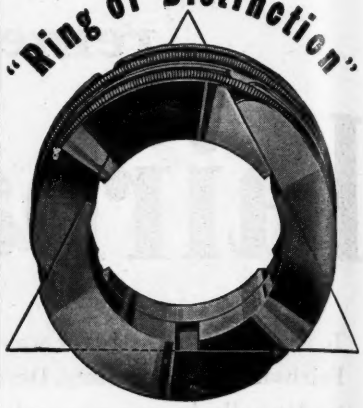
Pumps Water at any temperature or pressure
Open float cannot burst or waterlog
Valves and Seat Bronze or Stainless Steel
Sizes 1 in. to 4 in. inlet and outlet
Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.



Ask for catalogue and prices

TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.

"Ring of Distinction"



Install FRANCE Metal Packing for "Round-the-Clock" Production

The renewal of ordinary packing every few weeks or months increases horsepower and production costs.

Minimum friction is encountered with France Metal "Ring of Distinction" Packing. No undue force can be exerted on rods or stems by tightening the stuffing box stud nuts. The rings are free to float in the case that retains them and are held to the rod or stem with a garter spring having minimum tension.

The result is tight "full floating", trouble-free performance for years. Prompt delivery assured.

FREE

44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-5, with facts on

- Packing Designs for Any Service
- Installation Procedure
- Methods of Lubrication
- Pressures and Temperatures
- Oil Return and Stripping Rings
- Handy Reference Tables

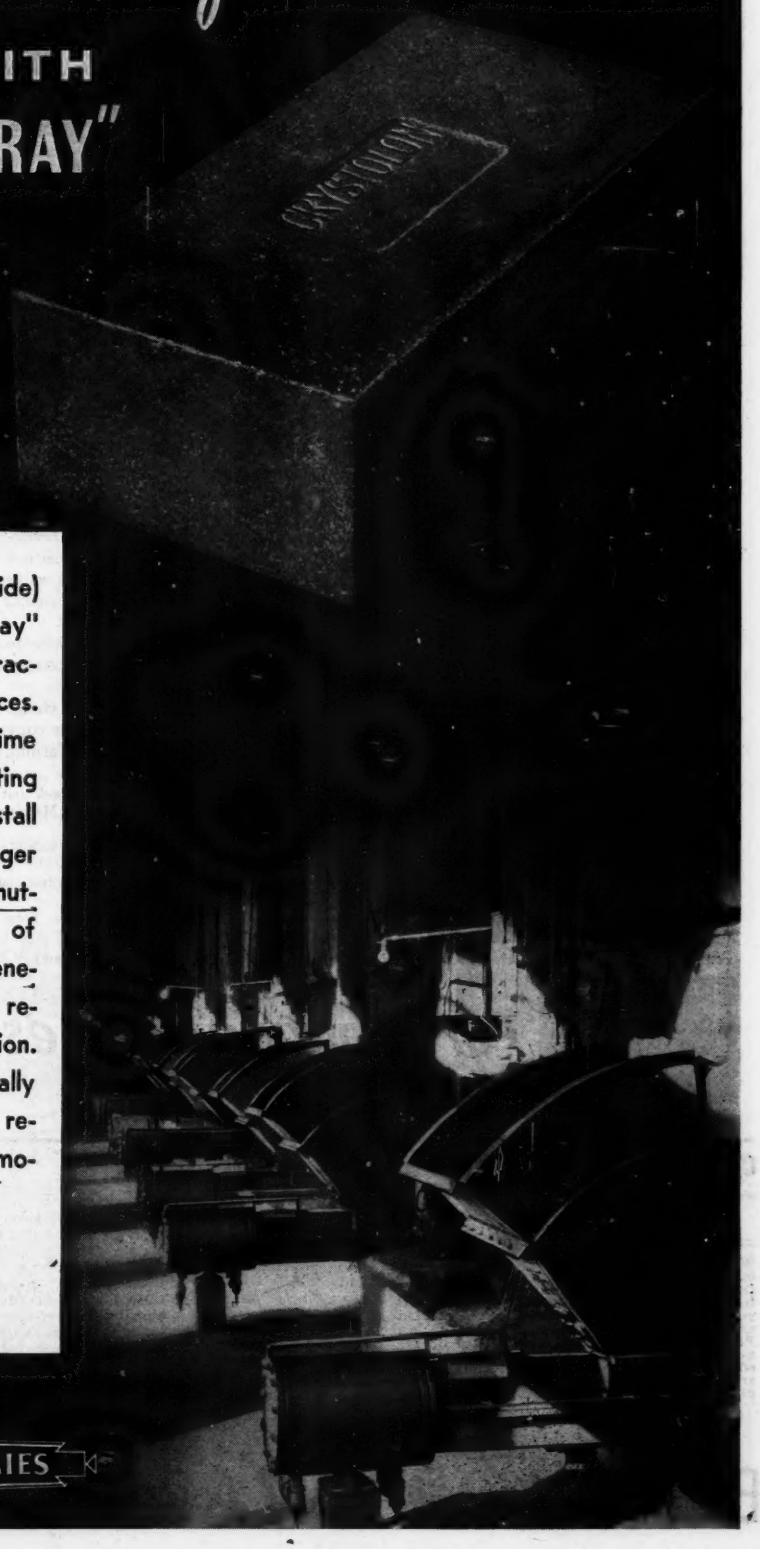
Request France Engineers to analyze your packing requirements. There is a representative close at hand.

THE FRANCE PACKING COMPANY
Tacony, Philadelphia 35, Penna.
Branch Offices in Principal Cities

Original FRANCE METAL PACKING

CRYSTOLON BRICK *for Boiler Furnaces*

DO AWAY WITH "WATCH AND PRAY" METHODS



CRYSTOLON (Silicon Carbide) brick banish "watch and pray" methods when it comes to refractory linings for boiler furnaces. With plants operating at wartime peaks and with many operating men in service, it pays to install these brick which guarantee longer life with fewer and briefer shutdowns. The dense surface of Crystolon brick cannot be penetrated by slag, making clinker removal a short, easy operation. Highly refractory and chemically inert, these rugged brick are resistant to abrasion such as the motion of the firebed.

NORTON COMPANY
Worcester 6, Mass.

NORTON REFRACTORIES

One

OF THE COMPLETE LINE...
PYREX BROAD RED LINE

For use in
those "Hard to See" Places

The PYREX Broad Red Line Gauge Glass is made just for that purpose—to make it easier for you to see the water line where visibility is poor. The broad red transparent line is magnified by the water column so that the liquid level is clear and distinct.

Made with machine drawn accuracy—that reduces breakage from installation strains; made from special resistant glass, they withstand solvent action of steam or hot water and sudden temperature changes and mechanical shock. They stand up under severe operating conditions.

Regardless of your requirements, you will be able to select the right Gauge Glass from the complete CORNING and PYREX Line.

Bulletin 817 tells you more about these Gauge Glasses and the places they fill. Write for your copy to Industrial Sales Department, PF12, Corning Glass Works, Corning, N. Y.

PYREX brand High Pressure—resistant to thermal shock and mechanical shock and attack of steam and hot water. Machine drawn accuracy.

PYREX brand Red Line—Same but with added visibility afforded by enameled red line.

PYREX brand Broad Red Line—Same but with fused-in broad red line for extra visibility.

CORNING Standard—For moderate pressures. Long-lasting. Machine drawn accuracy.

"PYREX" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Consult us for:

Radial Brick Chimneys

Common Brick Chimneys

Ornamental Chimneys

Linings for Steel Stacks

Chimney Repairs and Extensions

Installing, Repairing Lightning Rods

AMERICAN CHIMNEY CORPORATION

147 Fourth Ave., New York 3, N. Y.

BRANCHES: BOSTON, MASS.
PHILADELPHIA, PA. • PITTSBURGH, PA.
CLEVELAND, O. • DETROIT, MICH.

CLASSIFIED ADVERTISING

SALESMEN AND AGENCIES

AGENTS—We want men to handle a time-tested process Condensate Return System which we sell on Guaranteed quick payout saving basis with liberal compensation. Address Box 1461, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

MANUFACTURERS—Is your distribution satisfactory on the Pacific Coast? A well established and progressive sales organization with a record of consistant coverage of all types of industrial and marine trade can handle one or two more steam specialties. This Company has an excellent record that will be an asset to you. We are interested only in quality lines of established reputation and only in exclusive sales contracts. Write Power Plant Engineering, Box 1462, 53 W. Jackson Blvd., Chicago 4, Ill.

HELP WANTED

WANTED ENGINEER
HEAT TRANSFER EQUIPMENT

Experienced, excellent opportunity with manufacturer having definite post-war plans Write fully. Only applications in detail considered. All information held in confidence. Address Box 1460, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

WANTED SALES MANAGER
HEAT TRANSFER EQUIPMENT

Manufacturer wants sales manager with good sales record and contacts. All applications must contain full details for consideration. Replies held in confidence. Address Box 1459, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

CLASSIFIED ADVERTISING

HELP WANTED

WANTED—Power Plant Operating and Combustion Engineer. Large concern, Chicago District, desires young man preferably with technical education, who has had several years' experience in power plant operation and in improving combustion efficiencies. Permanent position for man with proper qualifications. Applicants please give age, education, experience, salary desired and references. Address Box 1457, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

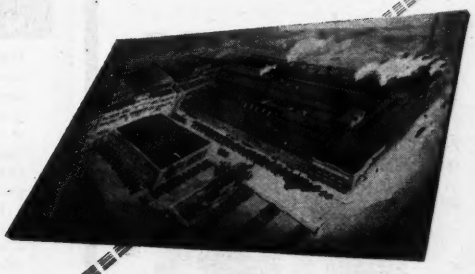
POSITION WANTED

Position Wanted—By engineer with 20 years' experience. Has broad knowledge of plant construction and maintenance, familiar with the construction and operation of reciprocating steam engines, steam turbines, diesel engines, generating units and switchboards. Have a good grasp of combustion and refrigeration. Have had particular success with power cost reduction and plant designing. Mechanical and Electrical graduated. Married. Address Box 1463, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

BUY MORE WAR BONDS NOW

One purpose ...

the IMPROVEMENT of Metals



Bracket Type Forging in which a high strength-to-weight ratio is obtained by forging in a set of locked, closed impression dies which form this part to close tolerances.

by Forging

Close temperature and processing control is a vital factor in developing the maximum metal quality in a forging of this shape. Maximum strength and toughness result from utilizing the exact production technique required for the utmost **IMPROVEMENT OF METALS BY FORGING.** Throughout 31 years of technical production effort, our engineers have utilized, over and over again, all of the known forging techniques; frequently improving a technique in order to obtain maximum metal quality. Consult one of our forging engineers for suggestions on how to produce such parts to close tolerances.

DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.

966 East 64th Street • Cleveland, Ohio

GRUV-SEAL "FORGED-IRON" RING GASKETS

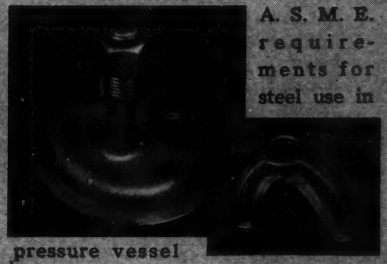
make pressure proof joints

With Gruv-Seal "Forged-Iron" Ring Gaskets Wrench Pressure Molds a Tight Seal That Stays Tight. These gaskets are manufactured by a special forging method which reduces metal porosity to a minimum and interlocks the metal fiber flow lines into a dense tough structure such as is obtained by no other fabricating process. Gruv-Seal "Forged-Iron" Ring Gaskets can be applied to all types of flanged fittings when grooved. They should be used at all valve bonnet joints, flange connections, and at joints where ready disassembly is a necessary requirement. Gruv-Seal Ring Gaskets are made in a wide range of sizes, including all standard A. P. I. sizes. Write for Gruv-Seal Gasket Booklet No. 20.

Diamond "S" Boiler and Tank Accessories were developed as the result of scientific analysis of requirements of pressure vessels and the practical application of well-known and highly desirable engineering principles. The outstanding advantage available from these units is a more generous *margin of safety for the protection of both men and materials.*

Diamond "S" Boiler and Tank Accessories include Manhole Cover Assemblies, Handhole Cover Assemblies, Welding Street Ells, Welding Fittings, Standard Flanges, Water Column Ells, Welding Necks. All

Diamond "S" Boiler and Tank Accessories fully meet and exceed A. S. M. E. requirements for steel use in



pressure vessel parts and are approved by the Bureau of Marine Inspection and Navigation for rated pressures.

DIAMOND S BOILER TANK ACCESSORIES

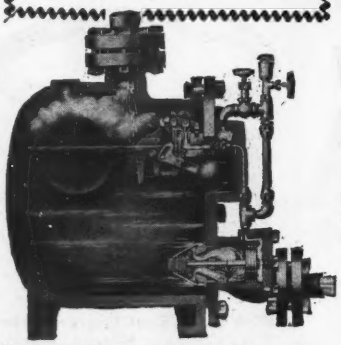
A complete line of forged steel boiler and tank accessories is illustrated, described and listed in Catalog No. 10, which also contains technical data and general information about these products. Write for a copy of Catalog No. 10.

THE STEEL IMPROVEMENT & FORGE CO.

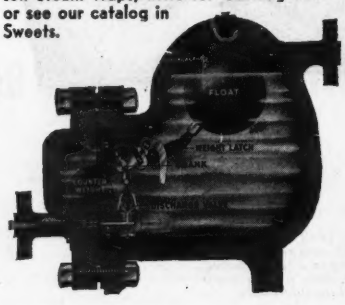
943 East 64th Street • Cleveland, Ohio

Nicholson Steam Traps

are **APPROVED** by POWER ENGINEERS for their **ENORMOUS** *Discharging Capacity*



FOR COMPLETE FEATURES of Nicholson Steam Traps, write for Catalog 444 or see our catalog in Sweets.



NICHOLSON TRAPS are today the preponderant choice of power and construction engineers, in every major line of American industry, because of their enormous discharging capacity, and their quick positive action. Nicholson designs and makes a trap for nearly every power and process purpose. Above, Model B piston operated steam trap, for pressures to 650 lbs. Right, Model C high pressure (to 1500 lbs.) weight-operated trap for steam, air and gasoline.

W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

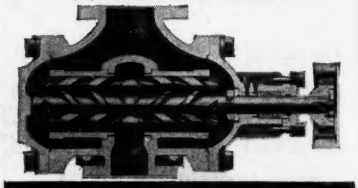
Valves • Traps • Steam Specialties

The IMO OIL PUMP *Small but Effective*

LIKE THE SUBMARINE ON WHICH IT IS USED

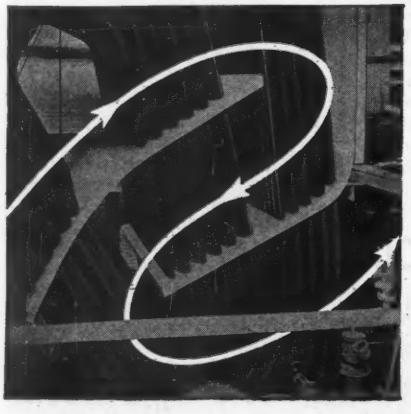
The submarine represents the most concentrated power known to naval warfare. Similarly, the IMO oil pump provides great concentration of pumping capacity in small space. It is extremely compact, rugged, simple and reliable, having only three moving parts and no valves or pilot gears.

The IMO oil pump is used on submarines for pumping both fuel and lubricating oils. You can use this small, but effective, pump for handling oil of practically any viscosity, in any volume, and at any pressure. Ask for Leaflet I-112.



IMO PUMP DIVISION

ENCO BAFFLES



- Streamline gas flow
- Scientifically curved surfaces
- Uniform gas flow
- Eliminate bottle necks
- Reduce draft losses
- Speed heat-transfer
- Keep heating surfaces cleaner
- Cut down on use of soot blower
- Adaptable to any type water-tube boiler
- Adaptable to any fuel
- Special provision for expansion
- Easy removal and replacement of tubes
- Designed for each installation
- Only selected materials used
- Baffles installed by skilled mechanics

save fuel

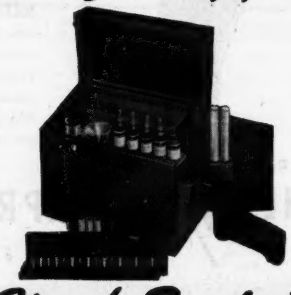
SEND FOR BULLETIN BW 44

THE ENGINEER COMPANY

75 WEST STREET Enco NEW YORK 6, N. Y.

Canada: F. J. RASKIN, INC. 370 Rachel E., Montreal, P. Q.

TAYLOR-*Standard of Accuracy*



Simple 2 minute BOILER WATER TEST

Increases Power...Saves Equipment

You can keep accurate check on the pH and Phosphate content of boiler water—easily and speedily with this portable Taylor Boiler Water Comparator. Outfit includes High or Low Phosphate Comparator, 3 pH color standard slides (7.2—11.6) and all needed accessories. Model W—complete in neat wooden carrying case . . . $50.00 F. O. B. Baltimore.

All Taylor liquid color standards carry AN UNLIMITED GUARANTEE AGAINST FADING.

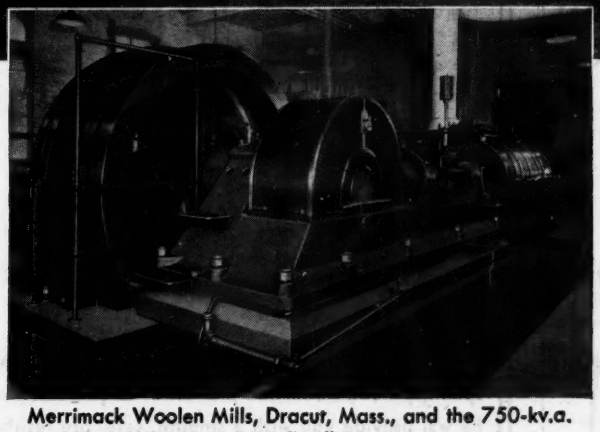
See your dealer or write for Free booklet: "Modern pH and Chlorine Control"

W. A. TAYLOR AND CO.

7301 YORK RD. • BALTIMORE 4, MD.

SKINNER "UNIVERSAL UNAFLOW" STEAM ENGINES

Generate Electric Power for 7



Merrimack Woolen Mills, Dracut, Mass., and the 750-kv.a. Skinner "Universal Unaflow" engine-generator unit.

M. T. STEVENS & SONS Founded 1813

M. T. STEVENS & SONS CO.

MANUFACTURERS OF

WOOLEN AND WORSTED FABRICS

M. T. Stevens & Sons Co., of North Andover, Mass., was founded in 1813, by the grandfather of Nathaniel Stevens, now president of the company. In that same year Lawrence met his death on board the "Chesapeake" outside Boston, and Perry won his victory on Lake Erie. It was the next year that Francis Scott Key penned our national anthem.

Through four great wars, and now in the fifth, this old reliable company has been furnishing fabrics for uniforms and other military purposes, and making millions of blankets for the armed forces. Stevens woolens and worsteds have an enviable reputation throughout the men's and women's wear and automobile upholstery trades.

For such textile mills an economical and dependable power supply is essential; and in many cases this power can be generated, with "Universal Unaflow" Steam Engines, largely as a by-product of process steam usage.

A remarkably large percentage of our business comes from those who already have Skinner engines. M. T. Stevens & Sons Co. is a typical "repeat" customer. In addition to the "Universal Unaflow" engine which generates electric power for Stevens' Merrimack Woolen Mills, there are four of these engines in their Minterburn, Hockanum and American Mills at Rockville, Conn.

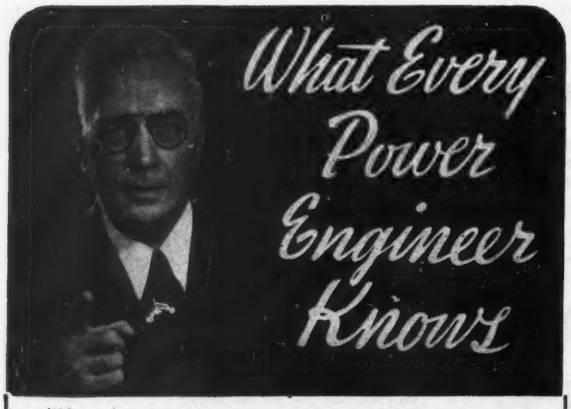
More than 2,000 power users, in industries and institutions of various types, have found it more economical to generate their electric power with Skinner "Universal Unaflow" Steam Engines. Literature describing these engines, and a List of Users, will be sent upon request.

Do More Than Before—Buy EXTRA War Bonds

ARMY E NAVY

For Over 75 Years, Doing One Thing Well—Building Steam Engines

SKINNER ENGINE COMPANY, ERIE, PA.



What Every Power Engineer Knows

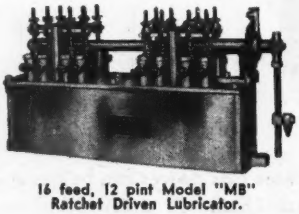
. . . is—that one neglected Bearing may close his plant!

The lubrication of your power equipment must be MECHANICAL to be positive.

HILLS-McCANNA
FORCE FEED
Lubricators

. . . have been recognized as standard equipment in power plants, large and small, for 73 years.

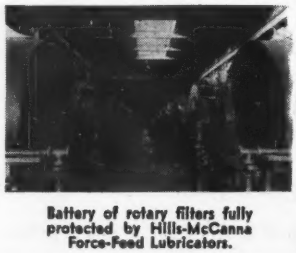
3 feed, 4 pint Model "ET" Lubricator.



16 feed, 12 pint Model "MB" Ratchet Driven Lubricator.

A SIZE AND TYPE FOR *EVERY* SERVICE

- They Save Labor—by automatic operation.
- They Save Oil—by feeding correct dosages.
- They Save Bearings—by positive force-feed oiling.
- They Prevent Shut-downs—due to human failure in lubrication.



Battery of rotary filters fully protected by Hills-McCanna Force-Feed Lubricators.

Our lubrication engineers will be glad to advise with you —without obligation . . . or write for Catalog L-44-A.

HILLS-McCANNA CO.
2439 NELSON STREET, CHICAGO, 18
PROPORTIONING PUMPS • AIR & WATER VALVES • CHEMICAL VALVES
MARINE VALVES • FORCED FEED LUBRICATORS • BOWMETAL CASTINGS

ONLY ONE MAN DOES IT...

IT ONLY takes one man to resurface your rough and splintery wood floors and platforms. In just four steps he will provide you with a smooth, safe, fire-resistant and tough hard-wearing floor which bonds perfectly to the old surface.

There is no need to rip up the old floor . . . No expensive labor or involved preparation or special equipment necessary.

Just write for information and TRIAL OFFER on

STONHARD RESURFACER

200,000,000 Sq. Ft. in Use by Over 100,000 Customers

30 MAINTENANCE PRODUCTS

STONHARD COMPANY

Now in Our 23rd Year

811 TERMINAL COMMERCE BLDG.

Philadelphia 8, Pa.

SALES OFFICES AND STOCKS IN PRINCIPAL CITIES

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT EQUIPMENT

1 **Ram Feed Stoker**—Bulletin 400 describes the Lo-set stoker, one of Canton's 54 types and sizes for needs up to 800 hp. Ruggedly constructed to meet severe service demands with trouble-free performance . . . backed by five year guarantee. Canton Stoker Corp.

2 **Steam Plant Data** — "Dividends from Your Power Plant" is the title of an interesting booklet, telling in non-technical language what engineers and plant managers ought to know about steam generation and boiler efficiency. Preferred Utilities Co.

3 **Fireclay Refractories** — Attractive 8-pg bulletin describes H-W fire brick, bonding mortars, bulk insulation, ramming materials. Contains helpful table of brick weights, insulating value, etc. Harrison-Walker Refractories Co.

4 **Fuel Oil Purifier** — Attractively illustrated 8-pg Bulletin 65 shows operating features and typical applications of Honan-Crane fuel oil purifier. Also contains U. S. and metric weights and measures and other useful engineering data. Honan-Crane Corp.

5 **Boiler Data Book** — Bulletin B-44-5-M on the S-A type boiler has been issued by Foster Wheeler Corp. It contains drawings and photographs, together with operating data at a number of well known plants. Method of operation, ability to fire two or three different fuels simultaneously are given; also numerous photographs showing close-up details of construction.

5A **Furnace Enclosures** — M. H. Detrick Co., in an 82-pg book printed in four colors, describes Detrick walls and arches as applied to a wide variety of furnace designs. It is an extremely helpful treatise for the designer and builder of furnace enclosures, as well as to the man in charge of maintenance.

ELECTRICAL

6 **Unitized Switchgear**—New booklets on Unitized switchgear are said to save 30 per cent of usual time required to order, build and install switchgear. Also contain many pages of factual easy-to-use switchgear information. Westinghouse Electric & Mfg. Co.

7 **Tri-Clad Motors** — Well illustrated and concise in style, publication GEA-3580 gives highlights on the design, construction and application of G-E Tri-Clad electric motors. Includes full details about the extra protection features and other advantages. General Electric Co.

8 **New Electrical Symbols Chart**—A new chart of electrical symbols for power, control and measurement is included in Bulletin 4403 published by The I-T-E Circuit Breaker Co. Chart is only 8½ in. by 11 in. in size, allowing it to be kept in a desk drawer, but can be unfolded to 17 in. by 22 in. for use as a wall chart or spread under a glass table top. Contains more than 500 symbols and switch sequence tabulations.

9 **Thermocouple Data Book** — A new enlarged edition of its Thermocouple Data Book and Catalog has been issued by Wheelco Instruments Co. It gives data helpful in selection of thermocouples, lead wire, protecting tubes, heads and insulators. Also included are millivolt tables on the various types of thermocouples, temperature conversion tables, tables on wire resistance and on pipe and wire sizes.

10 **Insulation Tester**—The new U. S. made "Megger" insulation tester, in plastic molded case, and said to have the same ruggedness and accuracy common to all "Megger" instruments, is described in new Bulletin 1735-PE. James G. Biddle Co.

FANS, PUMPS AND COMPRESSORS

11 **Condensation Return Pumps**—Yeomans heavy-duty condensate return pumps, for duties to 100,000 sq ft of direct radiation and pressures up to 100 lb, are described in new Bulletin 5500. Contains helpful sectional views, selection chart, installation diagram. Yeomans Brothers Co.

12 **Hydraulic Handbook**—60-pg Aldrich Bulletin 50 contains authoritative hydraulic information and tables, under headings: Water head equivalents, Pump plunger loads, Hydraulic formulae, Plunger displacement, Pressure equivalents, Capacity of shafts, Electrical data, Pump discharge diagrams, Accumulator volumes, Friction losses in fittings and pipes, Capacities of pumps and cylinders, Pipe data, etc. The Aldrich Pump Co.

13 **Time-Saving Compressor Calculator** —An ingenious compressor calculator, designed to save time in computing compressor requirements or in estimating the performance of present compressor units has been prepared by The Cooper-Bessemer Corp. Pocket size, of slide rule design; can be used for quickly estimating the volumetric efficiency, brake horsepower and total piston displacement of any make of compressor.

14 **Steam Heat Vacuum Pump**—Specifications, sizes and capacities of Warren steam heat vacuum pumps are given in new Bulletin 226-1. Rigidly supported valve gear may be adjusted while pump is in operation. Warren Steam Pump Co.

INSTRUMENTS AND CONTROLS

15 **Centralized Combustion Control**—With many sectional views and diagrams, Publication No. 38-304 describes the operating advantages of Hays centralized · combustion control system. Holds steam pressure virtually constant under wide variations in steam demand. The Hays Corp.

16 **Pressure Controls** — Informative bulletin describes the McAlear line of precision engineered pressure, flow, liquid level and temperature controls for steam, water, air, oil and gas. Company engineers will design and develop special controls for specific applications. McAlear Mfg. Co.

17 **Temperature Regulators** — Catalog 70 contains eight sections of useful engineering data on reducing valves, temperature regulators, pump governors and sirens. Foster Engineering Co.

18 **Gages for All Kinds of Liquids**—Bulletin 1037 describes a complete line of liquid level gages for measuring liquids of all kinds whether light or heavy. Dial readings can be provided in feet, inches, gallons, pounds, liters or by any other desired increment. By using these gages accurate inventory of liquids is constantly available. The Liquidometer Corp.

19 **Water Level Gages** — Fully illustrated 8-pg bulletin on bronze, forged steel and iron gages for boilers and tanks; all kinds of industrial applications. Specifications and dimensions are given. Ernst Water Column & Gage Co.

MECHANICAL TRANSMISSION

20 **Speed Reducers** — New comprehensive catalog gives advantages, rating tables, recommended practice for herringbone, planetary, spiral gear and other types of D. O. James speed reducers. A valuable reference book for engineers with power drive problems. D. O. James Mfg. Co.

21 **Standard and Specialized Belts** — New catalog furnishes complete information on the Gilmer line of standard V-belts, endless or non-endless flat belts, and a complete range of specialized belts for use wherever standard belts are unsuited. L. H. Gilmer Co.

22 **Bearing Metals**—8-pg bulletin gives many helpful hints on how to keep bearings on the job and shows what bearing metal to use for every application. A useful reference for operating and maintenance men. Magnolia Metal Co.

23 **Unique V-Belt Applications**—Industrial News, a 4-pg monthly bulletin issued by Gates Rubber Co., describes a number of jobs on which V-belts replaced chain and other hard-to-get materials. Includes pictures and performance data.

PIPING, VALVES AND FITTINGS

24 **Branch Pipe Outlets** — WeldOlet method makes possible the installation of branch pipe outlets, without removing main pipe from line. Available in welding, threaded and socket outlet types —size-to-size and reducing sizes from ¼ in. to 24 in. Write for bulletin WT31. Forged Fittings Div., Bonney Forge & Tool Wks.

25 **Seamless Flexible Metal Hose** — Bulletin H 201-935 furnishes engineers complete data covering the physical properties and other pertinent information. Generously supplied with illustrations and diagrams, it is invaluable to engineer, designer, and specification man. Eclipse Aviation Seamless Flexible Metal Hose, Philadelphia Div. of Bendix Aviation Corp.

26 **Steam Hook-Ups** — Service in the solution of any heating, cooling or temperature control problem is offered by experienced Sarco representatives. Send for "Steam Hook-Up" Book which gives diagrams, tables and recommendations of value to steam process and heating engineers. Sarco Co., Inc.

Coupon must be filled in completely to secure literature you request. Pasting coupon on penny postcard saves time and money.

DECEMBER, 1944

POWER PLANT ENGINEERING

53 W. Jackson Blvd.
Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the following paragraph numbers:

_____

_____

_____

Your Company Name _____

Company Address _____

Your Name _____

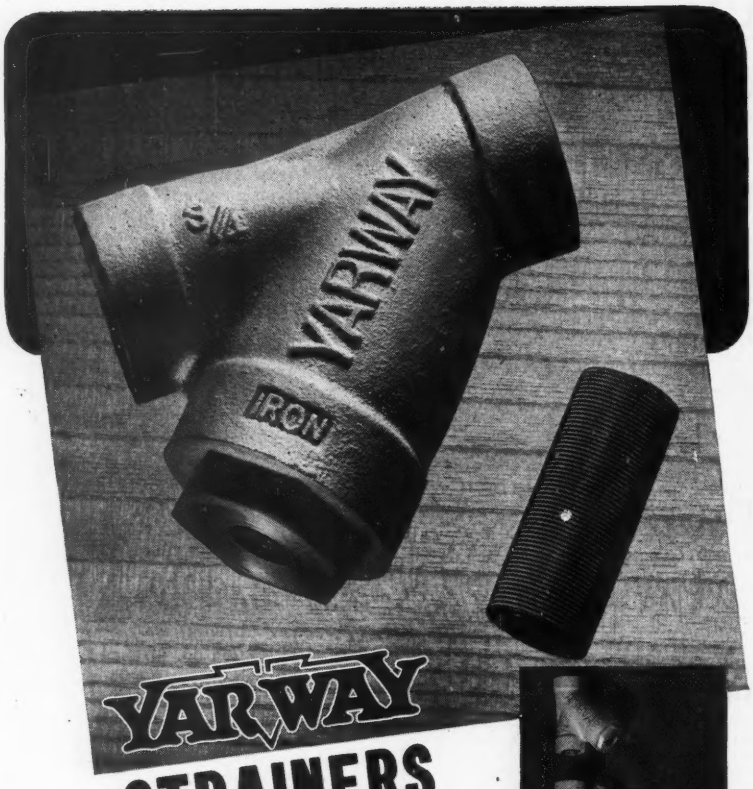
Your Title _____

City _____ State _____

(If you prefer delivery at your home also fill in below)

Home Address _____

City _____ State _____



STRAINERS "Police the Pipelines"

YARWAY STRAINERS are *selling by the thousands* because they are better engineered for the service.

"*The Screen is the Thing*"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.

Then, too, purchasers like the *body finish—Cadmium plating inside and out* for protection against corrosion.

And last but not least, it is "*Easy to Clean*" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.

Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.

Sold by over 100 Mill Supply Houses. See your Supply House or write for Bulletin S-200.

YARNALL-WARING COMPANY
114 Mermaid Avenue PHILADELPHIA 18, PA.

YARWAY STRAINERS

27 Tube Cleaners — Catalog 42 furnishes complete information on equipment for cleaning tubes of all kinds in which scale, carbon, rust, sludge or other fouling matters form. Operated by air, steam, water or electricity. Thos. C. Wilson, Inc.

28 Where to Use Valves, Drains and By-Passes—Thirty-two pages of interesting information tells you which valves to use, differences among the various types of valves, the fundamentals of valve designs and application. Jenkins Bros.

WATER TREATMENT

29 New Decarbonator Bulletin—Cochrane publication 2975 tells about Cochrane Decarbonators for removing certain dissolved gases from water solution. These Decarbonators have been successful in application for removal of carbon dioxide in connection with iron removal plants and with the degasification of hydrogen zeolite softened waters. Method of operation is explained. Cochrane Corp.

30 Ion Exchangers—Bulletin No. 1960 describes the action of Infilco ion exchangers which utilize principle of ion exchange of sodium for calcium and magnesium, hydrogen for other metallic ions present, etc. Many flow diagrams, installation photos and data useful to water treatment engineers. Infilco, Inc.

31 Chemical Feeders — Bulletin describes Manzel chemical feeders for automatic boiler feedwater treatment. Installed on boiler pumps, they automatically feed a small amount of chemical into the line with each pump stroke. Easily adjustable to fit your exact requirements. Manzel Brothers Co.

32 Scientific Water Conditioning—Bulletin covers Bird-Archer line of water testing equipment, conductivity apparatus, proportioning pumps and chemical feeds. Describes "Tanalginate," an organic colloid of reactive and protective type for treatment of boiler water. Eliminates baked sludge, permits increased boiler water concentrations, reduces blow-down. Bird-Archer Co.

MISCELLANEOUS

33 Centralized Lubricating Systems—New booklet describes the Alemite LubroMeter, a simple form of centralized lubrication which has only two moving parts in its valves, and satisfactorily handles both oil and grease. It can be used over a wide range of temperatures, operating successfully under any temperature conditions to which industrial machinery is exposed. It may be serviced from hand or power operated portable type guns, and is also available as a fully automatic system. Alemite Div., Stewart-Warner Corp.

34 Instant-Use Floor Patch — Bonds tight to old concrete — forms a smooth, solid, heavy-duty patch that withstands extreme loads. Easy to apply —simply shovel into hole—tamp—and run traffic over immediately. Write for descriptive folder. Flexrock Co.

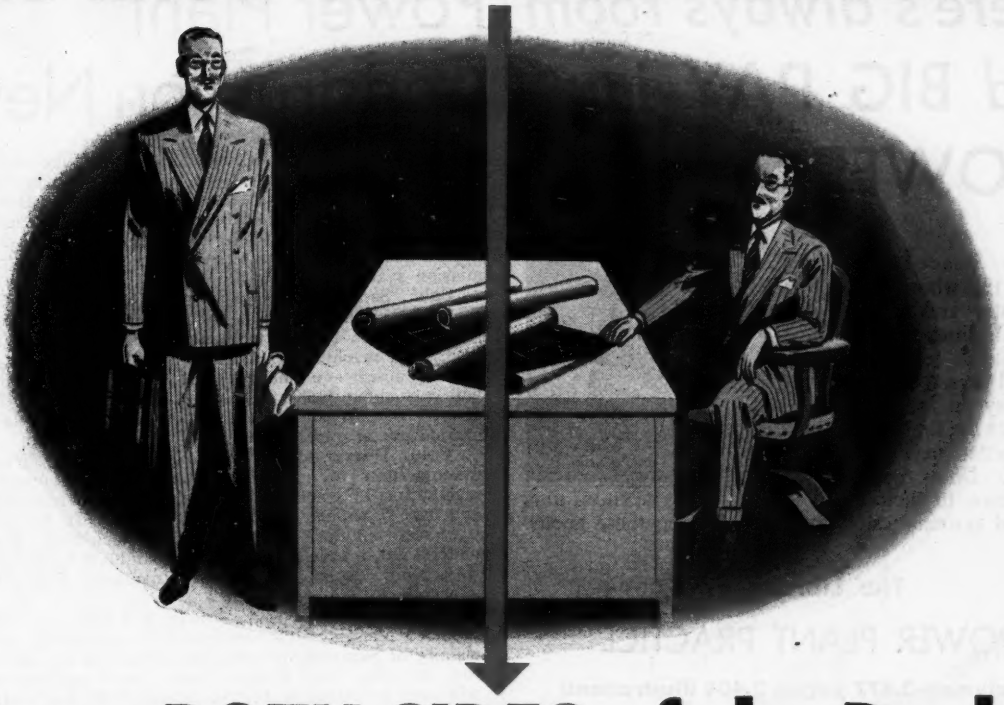
35 Summer Weather Data—New 128-pg handbook "Summer Weather Data" supplies designers of heat exchange systems with data that is helpful in selecting most economical combinations of equipment. Contains design data, statistics, charts, maps and technical analysis. The Marley Co.

36 Liquid Filters — How Staynew filters remove sediment from drinking or process water, oil and grease from condensate, sludge from quenching oils, dirt from fuel oils, etc., is explained in new bulletin. Staynew Filter Corp.

37 Free Repair Handbook — Company offers free 40-pg guide for the use of Smooth-On cements, containing 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

38 Heat Insulation Data Book—To help engineers select proper types of block, pipe covering and cement to fit given temperature conditions, Keasbey & Mattison Co. has issued a 36-pg data book. Contains tables of thickness, list prices.

WE KNOW THE PIPING PROBLEMS



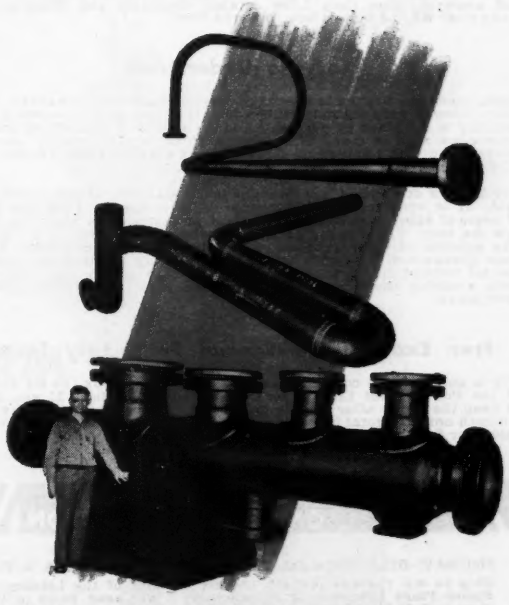
from BOTH SIDES of the Desk

Midwest not only fabricates piping for all purposes, but also operates an experienced contracting department that will deliver to the customer a completely installed piping system—ready for operation. Consequently, we have a clear view of piping problems from both sides of the desk.

Our contracting department is ever ready to make *practical* suggestions for improving pre-fabricated piping subassemblies. This continuous interchange of information and suggestions helps keep the entire Midwest organization on its toes; it is important in maintaining the high quality of Midwest piping.

Our contracting department is in constant and intimate touch with piping users in all types of industry. Changes in piping requirements . . . changes in the thinking of users are quickly relayed throughout the entire Midwest organization.

Midwest has four modern pipe fabricating plants strategically located to serve you . . . whether you need a simple bend or piping for an entire plant completely erected and ready for operation.



MIDWEST

PIPING & SUPPLY CO., INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Subsidiary: Lumsden & Van Stone Co., South Boston 27, Mass. • Sales Offices: New York 7—(Eastern Division) 30 Church St., Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St.

Piping Fabricators and Contractors

There's always room and BIG PAY *in* POWER

War or peace, keeping the wheels of industry and the nation's utilities turning is a basic job—one there's always room and big money in for the expert. Take the short-cut way to a better-paying power plant job. Do as thousands of others have, to their definite gain—spend a short time daily and systematically reading and using these books.

The Library of

POWER PLANT PRACTICE

(6 volumes—2,477 pages, 2,404 illustrations)

These six books cover the subjects of power plant practice completely and in every detail from the foundations and coal passing to the very tops of plant smoke stacks. They give you knowledge of boilers, steam engines, steam turbines, pumps, boiler-feed apparatus, and other equipment—their construction and performance—how to select them—how to test and maintain them—how to improve efficiency and economy in operating them. Descriptions, instructions, data, questions, problems and answers, more than 2,000 detailed diagrams and illustrations—make clear why as well as how to do the work.

Easy to Understand

These books are written in everyday easy-to-understand language. They are written to help the man on the job. It is just as if the author were working in the plant by your side and giving you the benefit of his vast knowledge, man to man. There's no bunkum in this Library, nor is it cluttered up with impractical theories. It is a Power Plant Library FOR POWER PLANT MEN.

The Library of Power Plant Practice is the standard of the power plant field. It is accurate—it is thorough—it is complete. It is the result of years of experience with power plant problems. The man who has it has the best. The Library covers the whole field—nothing is omitted. The solution of every problem is plainly worded or explained with a clear illustration. The little stickers and the big troublesome problems are all worked out in advance for you. There can be only one result from studying these books a few minutes each day—more money in your pocket.

Free Examination—Special Price—Easy Terms

Fill in and mail the coupon below and we will send you the six volumes of the Power Plant Library for 10 days' Examination. If you decide to keep the books after examining them, just send $2.00 and then $2.00 a month until the total low price of $16.00 has been paid. See the coupon below for details. Send it now.

McGRAW-HILL ON-APPROVAL COUPON

McGRAW-HILL BOOK CO., 330 W. 42nd St., New York 18, N. Y.

Ship to me, charges prepaid, the six volumes of the Library of Power Plant Practice. If satisfactory, I will send $2.00 in ten days and $2.00 a month until the price of $16.00 has been paid. If not wanted I will return the set to you postpaid. (To insure prompt shipment write plainly and fill in all lines.)

Name .....

Home Address .....

City and State .....

Position .....

Firm or Employer.....PPE. 12-44

Power Plant Construction News

Ark., Little Rock—Arkansas Power & Light Co., Pine Bluff, Ark., has tentative plans under advisement for new steam-electric generating station in vicinity of Little Rock, to be carried out as a postwar project. Cost estimated close to $4,000,000, with turbine-generators, high-pressure boilers and auxiliary equipment. Also, extensions in transmission system.

Calif., San Diego—Ryan Aeronautical Corp., Lindbergh Field, 2701 Harbor Dr., will carry out expansion in plant for production for Government, including additional buildings, with machinery and facilities for increased capacity. Electric power equipment will be installed. Entire program will cost about $1,000,000, and will be financed by Defense Plant Corp., Washington, D. C. Work is scheduled to be carried out at once.

Colo., Denver—Inland Paper Box Co., 1631 Wazee St., manufacturer of corrugated boxes and containers, plans installation of electric power equipment in new one-story and part basement plant, about 245 x 380 ft, on local site. Cost reported close to $250,000, with machinery. Project is understood to have a priority rating and will be placed under way soon. Roland L. Linder, Insurance Bldg., Denver, is architect.

Fla., Sarasota—Florida Power & Light Co., Miami, is reported planning new steam-electric generating station in vicinity of Sarasota, to serve that district, as well as Bradenton, Arcadia, Fort Myers, Punta Gorda and vicinity. It will have an initial capacity of about 19,000-kw, and is estimated to cost approximately $1,000,000. It is understood that project will be a postwar development.

Ill., Chicago—Storkline Furniture Co., 4400 West 25th St., manufacturer of infants' furniture, baby carriages, etc., plans new one-story plant on part of 22-acre tract of land bounded by Kostner and Kilbourn Aves., 18th St. and Cermak Rd., totaling about 95,000 sq ft floor space, to be carried out as a postwar project. Electric power equipment will be installed. Cost reported over $200,000. R. B. Kurzon, 134 North LaSalle St., Chicago, is architect.

Ill., Venice—Union Electric Co. of Missouri, St. Louis, Mo., through its subsidiary, Union Electric Co. of Illinois, Monsanto, Ill., plans postwar expansion at steam-electric power plant at Venice, including installation of new turbine-generator unit, high-pressure boilers and auxiliary equipment, to increase present rating by 120,000-hp. This will be part of a five-year development program now being arranged by company, beginning in 1945, estimated to cost about $45,000,000 for plants and distribution system. J. W. McAfee is president.

Ind., Indianapolis—Chevrolet Motor Division, General Motors Corp., 335 West 9th St., plans installation of electric power equipment in new additions to local plant for production for Government. About six new buildings will be erected for increased capacity. A boiler house will be built. Entire project is reported to cost in excess of $1,000,000, with financing provided by Defense Plant Corp., Washington, D. C. Proposed to begin work soon. Albert Kahn, Inc., New Center Bldg., Detroit, Mich., is architect and engineer. Main offices of company are at 3044 West Grand Blvd., Detroit.

Md., Baltimore—United Distillers of America, Ltd., 2700 Wilmarco Ave., plans installation of electric power equipment in new three-story addition to distillery for production for Government. It will be used as a byproducts plant for high protein animal feed from distillery waste. Cost estimated about $90,000, with financing provided by Defense Plant Corp., Washington, D. C. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., is engineer.

Minn., Minneapolis—Cornelius Co., 1621 East Hennepin Ave., manufacturer of air compressors, pumps, valves, etc., will make extensions in plant for production for Government, with machinery installation for increased capacity. Electric power equipment will be installed. Cost estimated about $200,000, with financing to be provided by Defense Plant Corp., Washington, D. C. Work will be carried out at once.

ROTA-SIGHT FLOW ALARM

gives positive protection against flow failure!

LIKE A TAUT SENTRY in the dark, this new flow alarm always stays on the alert. *"Advance, Flow, and give the countersign!"* If too low or too high, wham goes the big bell or swiftly a solenoid valve moves to a new position. Your product and your equipment will be surely and safely guarded by the Rota-Sight Flow Rate Alarm.

It is made with a transparent, V-ported metering tube, and a metal float which moves up or down *in direct response to flow rate changes only.* The float has a magnetic extension which trips an external switch to operate the alarm circuit. It responds equally well to flows of liquids or gases. Easily made explosion-proof.

The Rota-Sight Alarm is cast in all metals in sizes from ½" to 6". Without the alarm, it is an inexpensive, compact indicator of the true flow rate.

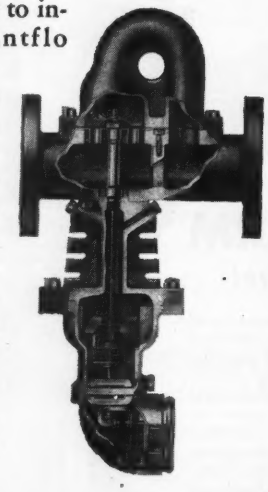
The Rota-Sight and Rota-Sight Alarm have been rapidly adopted by the leaders in the process industries and the equipment manufacturing Companies for measuring coolants, "lube" oils, chemical feeds, etc., to diesel engines, air compressors, turbines, filters, furnaces, stills, heaters, reaction vessels, etc. It has answered their needs for a positive, sure-fire flow rate indicator and alarm.

The interesting details are given in Bulletin 92-B—write for it on your Company letterhead.

FISCHER & PORTER CO. 5912 County Line Road HATBORO, PA.

BUILDERS
Shuntflo METER

On the job twenty-four hours a day, Builders Shuntflo Meter locates steam losses — saves 10 to 30 per cent on previously unmetered steam lines. Simple, rugged, low in cost and easy to install, the Shuntflo Meter accurately totalizes flow in pounds of steam or cubic feet of air or gas. Available for lines 1″ to 14″. Write for NEW Bulletin 349 — address Builders-Providence, Inc., 9 Codding St., Providence 1, Rhode Island.



BUILDERS-PROVIDENCE

Mich., Traverse City—State Administrative Board, Lansing, has authorized plans for new power plant at State Hospital at Traverse City, to be carried out as a postwar project. Cost estimated close to $750,000, with equipment. Allied Engineers, Inc., Penobscot Bldg., Detroit, Mich., is consulting engineer.

N. J., New Brunswick—Industrial Tape Corp., State Highway No. 25, New Brunswick, manufacturer of adhesive tapes, sensitized papers, etc., plans installation of electric power equipment in new one-story addition, about 200 x 200 ft, to cost over $100,000, with machinery. Project has a priority rating and will be placed under way soon. Company is a subsidiary of Johnson & Johnson, 500 George St., New Brunswick.

N. M., Eunice—Panhandle Carbon Co., Inc., 195 Madison Ave., New York, N. Y., producer of carbon black, with plant at Borger, Tex., has contracted with Government for construction and operation of new carbon black plant in vicinity of Eunice. It will comprise several one and multi-story structures, with processing equipment for large output. Also, compressor station, boiler house, pressure pipe lines and other facilities. Entire development will cost about $1,250,000, and will be financed by Defense Plant Corp., Washington, D. C. Work will begin soon.

Ohio, Cincinnati—Nivison-Weiskopf Co., Reading Rd., Reading, Cincinnati, manufacturer of corrugated boxes and containers, plans new boiler house at plant as a postwar project. Cost estimated over $80,000, with boiler units and auxiliary equipment. Fosdick & Hilmer, Union Trust Bldg., Cincinnati, are consulting engineers.

Ohio, Dayton—Inland Mfg. Division, General Motors Corp., 2727 Inland Ave., manufacturer of rubber specialties and plastic parts for automobile service, plans new two-story addition for manufacture of certain rubber products for Government. Electric power equipment will be installed. Entire project will cost close to $1,000,000 and will be placed under way soon.

Ore., Portland—Dairy Cooperative Assn., 1313 S.E. 12th St., plans installation of electric power equipment in new two-story milk-processing plant at East 6th Ave. and Tigard St., totaling about 75,000 sq ft floor space, estimated to cost close to $150,000, with machinery. Project has a priority rating and work will begin soon. Claussen & Claussen, Guardian Bldg., Portland, are architects.

Pa., Pittsburgh—Pittsburgh Coke & Iron Co., Grant Bldg., plans installation of electric power equipment in connection with expansion in byproducts chemical plant at coke ovens on Neville Island, comprising additional buildings and machinery for large increased output. Entire project is estimated to cost about $1,000,000. Project is understood to have a priority rating.

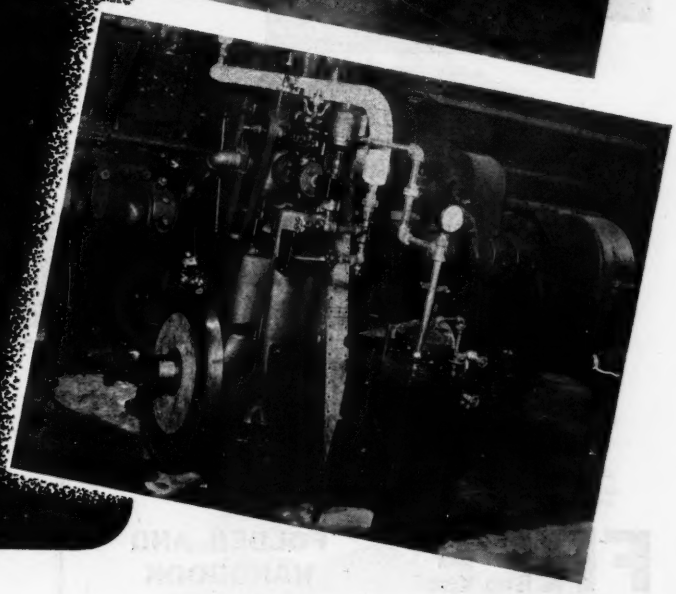
Texas, Altman—Continental Carbon Co., Sunray, Texas, has arranged with Government for construction and operation of new carbon black plant in vicinity of Altman, consisting of several processing and production units, with compressor station, boiler house, pressure pipe lines and other facilities. Cost estimated about $1,000,000, with financing to be provided by Defense Plant Corp., Washington, D. C. Work will begin soon. United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa., and Ship Channel, Houston, Texas, is engineer. Main offices of company are at 295 Madison Ave., New York, N. Y.

Texas, Houston—Nyotex Chemicals, Inc., Mellie Esperson Bldg., manufacturer of technical chemicals, plans installation of electric power equipment in connection with expansion in local plant at Green's Bayou, for production for Government. Program will include additional buildings with machinery for considerable increased output. Cost about $470,000, with financing provided by Defense Plant Corp., Washington, D. C.

Vt., Bellows Falls—Bellows Falls Hydro-Electric Corp., is projecting plans for new hydroelectric generating station on Connecticut River, as a postwar development, with construction of new power dam about 590 ft long and 60 ft high. This is part of a program to be carried out after war, to represent investment of over $7,000,000, for plant facilities, transmission and distributing lines and other work.

Wis., Cornell—Chippewa Valley Electric Cooperative, R. L. Cleaves, general superintendent, has surveys and plans under way for extensions in rural electric system in parts of Chippewa and Rusk Counties, totaling about 150 miles, with service connections and other operating facilities. Cost reported close to $160,000. Banister Engineering Co., 490 North Snelling Ave., St. Paul, Minn., is consulting engineer.

MAKE YOUR STEAM GIVE HEAT *AND* POWER



THERE is heat PLUS power in steam. When you use live steam for heating and processing purposes only, the power may be going to waste . . . costly waste.

Use both the power as well as the heat in your heating or processing steam by installing a Troy-Engberg Steam Engine.

You will have a dependable drive for stoker, blower, pump, compressor, or other equipment, and the exhaust at low pressure will provide effective heat.

Are engines economical? Troy-Engberg Steam Engines frequently write themselves off within two years, sometimes one.

TROY ENGINE & MACHINE CO.

Established 1870

870 RAILROAD AVENUE **TROY, PENNSYLVANIA**

12-TEM-1

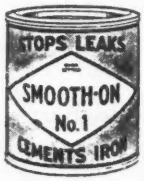
WHEN CONCRETE FLOORS NEED REPAIR

—here's the speedy way to get effective, durable lasting repairs that set overnight. Use Smooth-On No. 7B Quick Patch Cement. It comes in powder form, you mix it with water to a thick putty and apply as you would plaster. Smooth-On Quick Patch sets overnight, and expands slightly as it sets, forming a metal-hard repair that stays securely in place withstanding heavy traffic.

Order Smooth-On No. 7B in 5-lb., 25-lb. or 100-lb. sizes.

FREE FOLDER AND HANDBOOK

Send coupon for folder telling more about Smooth-On Quick Patch—also the free 40-page Smooth-On Repair Manual showing how to make countless repairs to plant and home equipment with Smooth-On Cements. 170 diagrams. Pocket size.



Get Smooth-On No. 7B from your dealer, or if necessary, from us. For your protection, insist on SMOOTH-ON, used by engineers and repair men since 1895.

FILL OUT AND MAIL NOW

Smooth-On Manufacturing Co., Dept. 31
570 Communipaw Ave., Jersey City 4, N. J.

Please send me the Smooth-On Repair Handbook, with folder on Smooth-On Quick Patch.

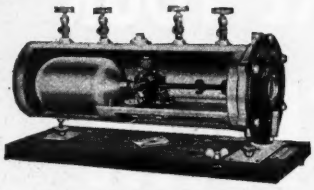
Name .....

Address .....

12-44 .....

Do it with **SMOOTH-ON**
The Iron Repair Cement of 1000 Uses

Measure Gas the AC-ME WAY



▼

GAS GRAVITY BALANCE

Gives dependable and accurate results on wet gas, dry natural gas and artificial gas. In determining the specific gravity of gas, will give results that can be checked within 3 points in the fourth place.

Designed for laboratory, plant and field.

Write for complete specifications.

LABORATORY APPARATUS
SCIENTIFIC INSTRUMENTS
POWER PLANT EQUIPMENT

THE REFINERY SUPPLY CO.

Main Office and Plant
621 E. 4th St. • TULSA 3, OKLA. • Ph. 4-8144, L.D. 581

Branch Office:
1309 Capitol Ave. Houston 2, Texas Ph. Fairfax 5514

WANTED:

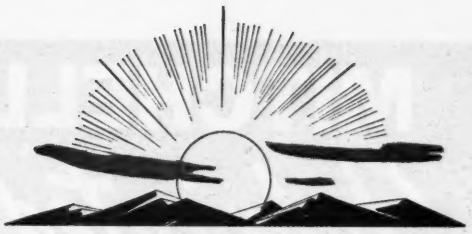
NEW POWER PLANT SPECIALTIES

To Manufacture and Market

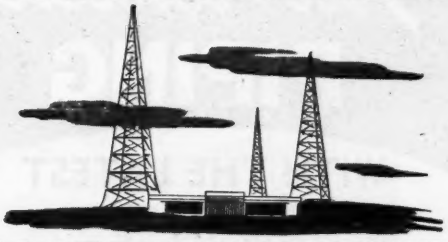
A manufacturer of steam power plant equipment with 40 years' experience in this field and a nationwide sales organization is interested in adding several new products to his line. This company has a strong financial position and has adequate research facilities for testing new products and doing any further development that may be needed. Address all information to

WITTE & BURDEN • ADVERTISING
5757 Cass Ave., Detroit 2, Mich.

A Great Electronic Day...

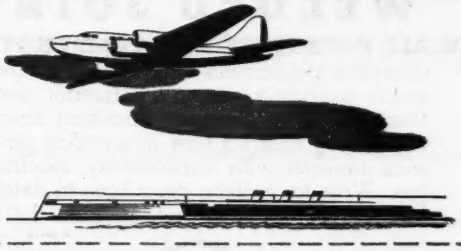


for Communications



for Industry

for Transportation



for Home

Raytheon is proud of its contributions in the development of new electronic tubes and complete electronic equipment for the Armed Forces. Proud of the trust the military has placed in our designs, engineering and manufacturing abilities.

When war ends, Raytheon's wartime experience, research facilities, engineering and the production skills of over 16,000 men and women will be turned to peacetime electronics. Then you'll hear about and see Raytheon Electronic Equipment that will provide untold benefits in all phases of electronics. In the coming Age of Electronics . . . LOOK to Raytheon for complete electronic equipment and electronic tubes.

Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the entire Blue Network. Consult your local newspaper for time and station.

R RAYTHEON

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.

MITCHELL *Fabricated* PIPING

WITH THE LATEST IN POWER PIPING DESIGN

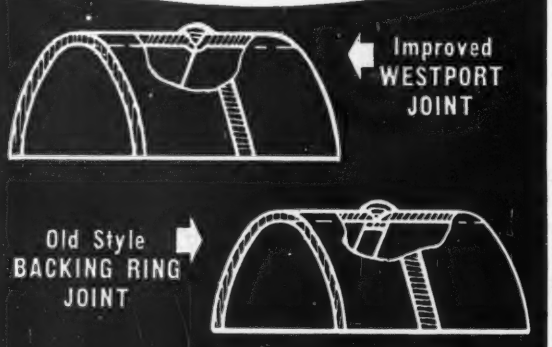
including the New

WESTPORT WELDED JOINT

FOR ALL PRESSURES AND TEMPERATURES

Complete penetration with smooth, sound welds providing streamline interior contour and *without* the use of Backing Rings which may obstruct flow or sacrifice pipe wall strength with unnecessary machining. Write for bulletin describing in detail advantages of Westport Welded Joint.

1899 M 1944

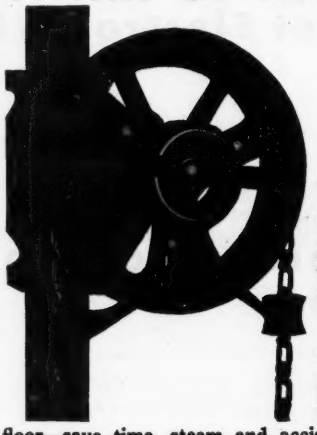


W. K. MITCHELL & CO., Inc.

PHILADELPHIA 46, PENNA.

Fabricators and Erectors
Specialists in Alloy Piping

Think of the TIME You'll Save



with Babbitt Sprocket Rims on all your "high-up" valves. No need of keeping a long, cumbersome ladder always on hand just to close a valve.

Babbitt Rims give you instant and positive control of overhead valves from the floor—save time, steam and accidents. Adjustable to any valve, easily attached and low in cost. Don't delay. Get your Babbitt Rims now! Complete information on request.

BABBITT STEAM SPECIALTY CO.

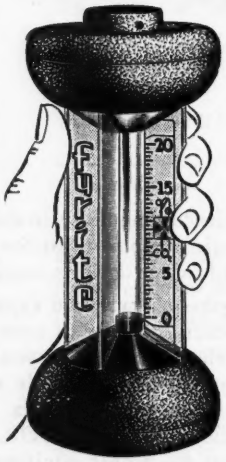
South Water, Spring and First Sts.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

COOPERATE with the NATIONAL FUEL EFFICIENCY PROGRAM **TO SAVE VITAL WAR FUELS**

USE THE **PRACTICAL FYRITE CO_2 INDICATOR**

REVEALS FUEL WASTE *INSTANTLY!*



$18.50 COMPLETE WITH INDUSTRIAL TYPE FLUE FILTER

CO_2 analysis of the flue gases is the only method available for determining the percentage of fuel wasted up the stack. The practical FYRITE CO_2 Indicator makes accurate flue gas tests easy—quickly pointing the way to adjustments and repairs necessary to secure efficient fuel utilization. The FYRITE requires no skill or technical knowledge; is simple and rugged; has no valves, clamps, or leveling bottle, no glass parts or batteries.

OXYGEN INDICATOR designed on same principle available soon. Write for particulars.

BACHARACH
Industrial Instrument Co.
7000 BENNETT ST.
PITTSBURGH 8, PA.

RETURN THIS COUPON FOR BULLETIN 341 on FYRITE. *Learn how to get immediate delivery under priority regulations.*

Name _____

Address _____

City _____ State _____ PP

Any equipment will burn it- if properly engineered

WELL engineered designs will permit the efficient use of a wide range of coals. Low fusion coals offer the best value for the fuel dollar. There is a strong trend toward the use of these low steam cost coals.

Carefully drawn coal specifications should be presented to the equipment manufacturer for design purposes to permit the utilization of a wide range of coals competitively available. You are urged to consult the Fairmont Coal Bureau's fuel engineers *before* your plant is in the blueprint stage.

For up-to-the-minute information on fuel economics and its relation to steam plant design, ask us to place you on our mailing list to receive copies of "Coal Reference Bulletins." Use coupon below in sending for these bulletins.

LOW FUSION FAIRMONT COAL MEETS EVERY REQUIREMENT FOR LOW COST STEAM GENERATION . . . . . .

- . . . . it can be burned economically in any equipment properly engineered for their use.
- . . . . huge reserves extend the availability of these coals into the far distant future.
- . . . . it easily represents "the best value for the fuel dollar" for long range planning.
- . . . . engineering to use FAIRMONT COAL assures the lowest overall steam cost for the life of the plant.

FAIRMONT COAL BUREAU

CHANIN BLDG. 122 E. 42ND ST.

NEW YORK 17, N. Y.

FAIRMONT COAL BUREAU · FAIRMONT REGION · WEST VIRGINIA · SERVICE TO INDUSTRY ·

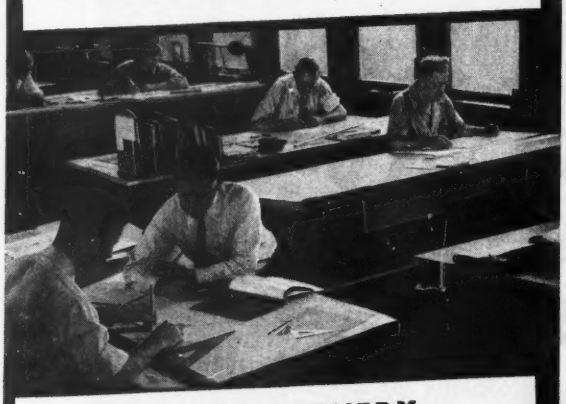
Fairmont Coal Bureau
Chanin Bldg., 122 E. 42nd St., New York 17, N. Y.

Kindly place me on your mailing list to receive copies of "Coal Reference Bulletins". It is understood these will be sent me FREE and without obligation.

MAIL COUPON TODAY

Name .....
Company .....
Position .....
Address .....

FROM ENGINEERING



THROUGH EVERY MANUFACTURING PROCESS

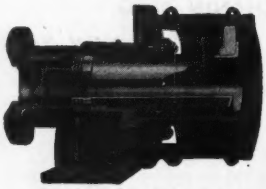
ADSCO EXPANSION JOINTS

Offer Exclusive Built-in Features

In ADSCO'S large, modern plant with foundry and expert welding equipment, skilled workmen make a wide range of ADSCO Expansion Joints to meet exact code standards. They build them with bronze, semi-steel or steel bodies — for controlling the expansion of low or high pressure steam, hot water, gasoline, oil, air or other pipe lines.

Exclusive features of ADSCO Joints include the internal guide ring to prevent the slip from pulling out of the body — the external, two-piece removable guide — the Piston-Ring joint which can be unpacked and repacked under full operating pressure without interruption to service — the Duplex-Sleeve Joint, etc.

All joints described in ADSCO Catalog No. 35.



ADSCO Piston-Ring Joint

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, NEW YORK
Makers of UP-TO-DATE Steam Line Equipment For Over 65 Years

EVERY BOILER
SHOULD HAVE ITS OWN . . . .
CAT'S-EYES

FOR BETTER COMBUSTION

THE BEST BOILERS ALSO USE
ESS HAZEGAGES
or
WYD-ANGLE PERISCOPES

ESS INSTRUMENT CO., FORT LEE, N. J.

Indicators, Controllers, and Recorders for Smoke Haze and Combustion . . . Specific Gravity . . . Turbidity . . . Flame Failure . . . Industrial and Safety Applications

C. H. Wheeler of Philadelphia

STEAM CONDENSERS
•
STEAM EJECTOR TYPE VACUUM PUMPS
•
MECHANICAL DRAFT WATER COOLING TOWERS
•
DECK MACHINERY

C. H. WHEELER MFG. CO.
19th ST. and LEHIGH AVENUE, PHILADELPHIA 32, PA.

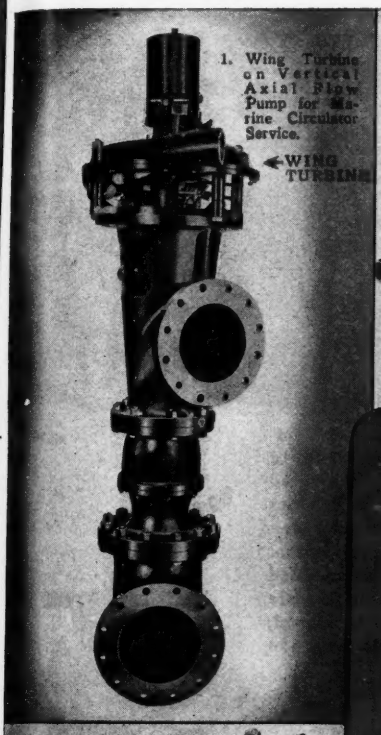
WICKES

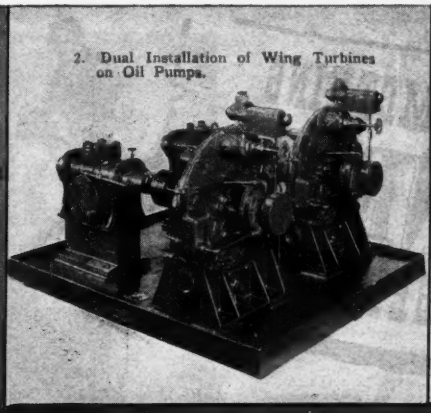
Horizontal Cross Drum Boilers
Vertical Water Tube Boilers
Inclined Curved Tube Boiler
Horizontal Tubular Boilers

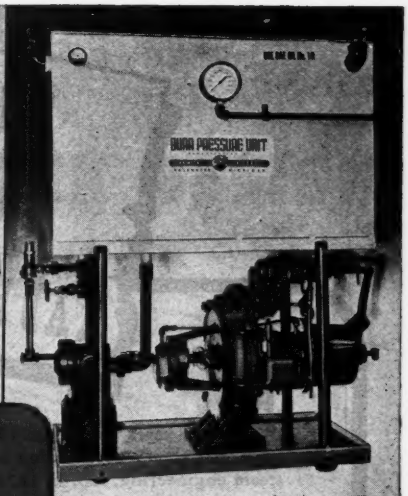
BOILERS

The WICKES BOILER CO.
SAGINAW, MICH.

SALES OFFICES
NEW YORK, 505 FIFTH AVE. PITTSBURGH, 1218 EMPIRE BLDG.
DETROIT, GENERAL MOTORS BLDG.
CHICAGO, 33 S. CLARK ST. SEATTLE, 736 HENRY BLDG.


1. Wing Turbine on Vertical Axial Flow Pump for Marine Circulator Service.


2. Dual Installation of Wing Turbines on Oil Pumps.


3. Compact arrangement of Wing Turbine on Special Oil Circulating System for Oil Field Service.

WING
AUXILIARY TURBINES
PRIME MOVERS FOR

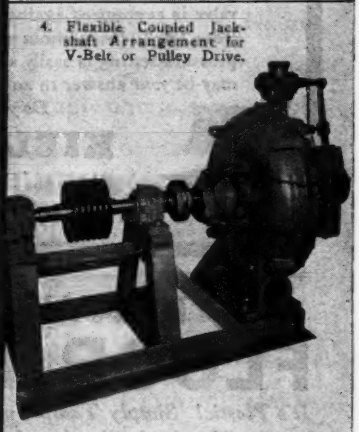
PUMPS · FANS · STOKERS
MIXERS · MARINE GEAR
WINCHES · GENERATORS
· COMPRESSORS ·

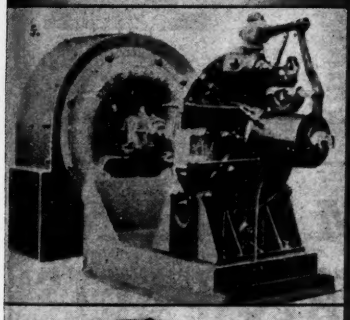
Wing auxiliary turbines have been a dependable source of power in industrial and marine applications for over a third of a century.

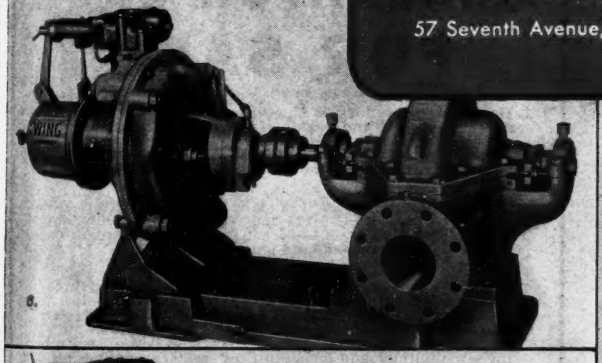
Write for a copy of Bulletin SW-1

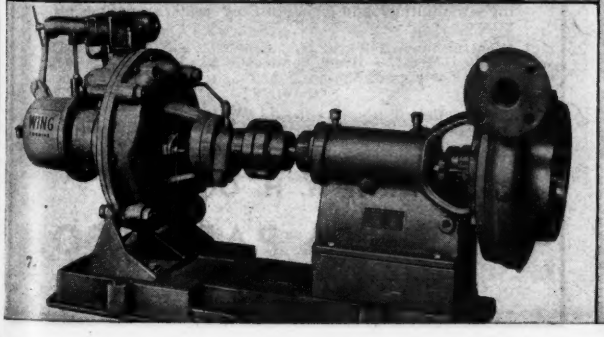
L. J. Wing Mfg. Co.

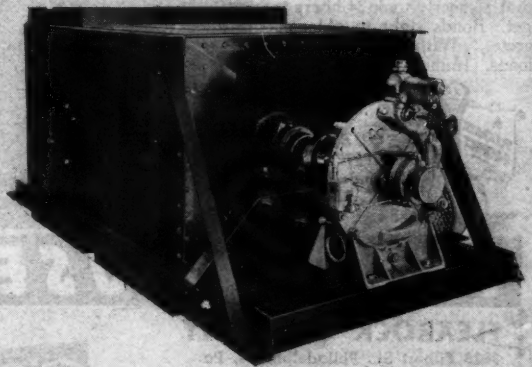
57 Seventh Avenue, New York 11, N. Y.


4. Flexible Coupled Jackshaft Arrangement for V-Belt or Pulley Drive.


5.


6.

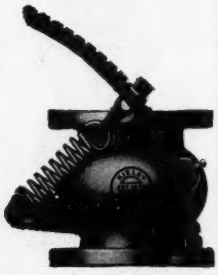

7.


8. Wing Turbine Driven Draft Inducer for Marine Service where Low Head Room is required. Integral By-Pass is incorporated.

5. At Left, Typical Centrifugal Fan Application.
6. & 7. Wing Turbines on Main and Auxiliary Condenser Pumps for Marine Service.

SOMETHING NEW HAD BEEN ADDED!

Forty-one years before the 19th Amendment permitted national women's suffrage, fair voters were casting ballots in municipal elections at the Massachusetts polls. In steam engineering, too, in 1879, something new had been added. Tim Kieley introduced the steam trap...the daddy of them all. For 3 generations since then, K&M Specialties have benefitted from this pioneering headstart. Today's K&M Type 554 combination Back Pressure and Atmospheric Relief Valve is an example. In any service where constant pre-determined back pressure and absolutely tight shut-off are required, this water-sealed valve is *guaranteed* against leakage or back flow. Sizes from 2" to 24", to handle pressure from 2 to 30 lbs. without pounding or chattering. Installation may be vertical or horizontal; pressure setting is easily adjusted; servicing, when necessary, is extremely simple. Type 554 may be *your* answer to an unsolved problem.



Do you have our General Catalog #66? Write for it.

KIELEY & MUELLER, INC.

MANUFACTURERS OF PRESSURE AND LEVEL CONTROLS SINCE 1879

NORTH BERGEN, NEW JERSEY

HEAVY DUTY FLOOR PATCH

It's Plastic! Simply Tamp Smooth . . . Truck Over!

Just the thing for keeping busy industrial floors in smooth repair . . . without interrupting traffic. Unlike old-fashioned resurfacers, INSTANT-USE is ready for service almost the moment it's put down. There is no waiting. To fix holes and ruts, you simply roll a drum of INSTANT-USE over to the hole in the floor, shovel out enough to fill the hole, tamp smooth and then pass traffic over the spot immediately. You'll have a tough, solid, permanent patch that formerly took 24 hours to get. Bonds tight to old concrete. Withstands extreme loads. Immediate shipment.

REQUEST DESCRIPTIVE FOLDER and Details of FREE TRIAL OFFER

INSTANT-USE

FLEXROCK COMPANY

3623 Filbert St., Philadelphia 4, Pa.

Please send me complete INSTANT-USE information and details of FREE TRIAL OFFER—no obligation.

Name .....

Company .....

Address .....

STEAM ENGINE GENERATOR SETS FOR SALE

1 Harrisburg Foundry & Machine Works 20" x 16" horizontal single cylinder side crank automatic steam engine—No. 4955—single eccentric—slide valve—72" x 16" flywheel 15" cast sub-base—outboard stand and bearing for generator including field rheostat for generator.

1 General Electric Co. 125 k.w. D/C generator—No. 1198954—type MPC-6-125-250 form LD—1000 Amp. 120/125 V 250 R/P/M/—direct connected to steam engine—including wiring and panel board.

* * *

1 Murray Iron Works 16" x 36" horizontal single cylinder side crank Corliss valve steam engine—No. 3083—heavy rolling mill frame—double eccentric—drop cut-off—flyball governor—12' dia. x 14" flywheel—outboard stand and bearing for generator—gravity and force feed oiling—including field rheostat for generator and pipe guard.

1 Westinghouse 200 k.w. D/C generator—No. 613407—125 V 100 R/P/M/—direct connected to steam engine—including wiring and panel board.

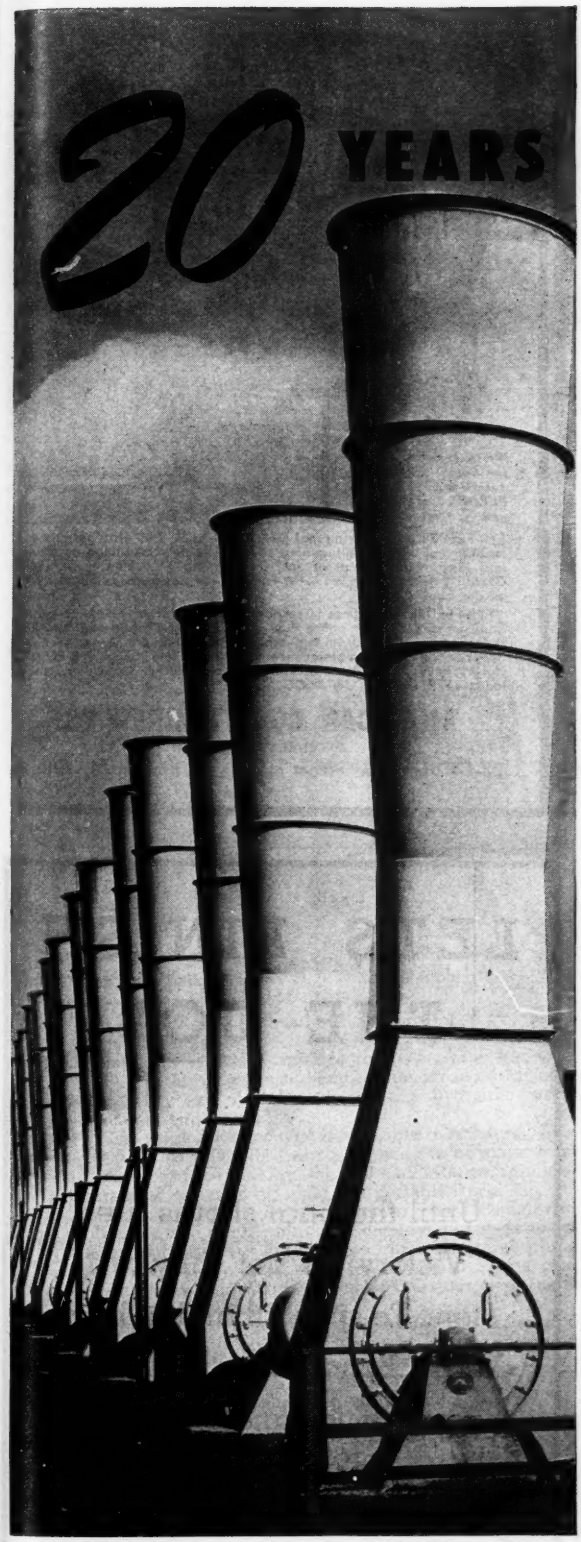
* * *

Price furnished upon request. Will sell all or part of above equipment. Can be seen in operating condition.

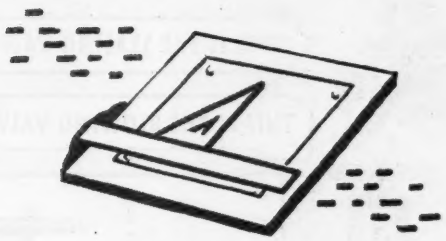
WRITE H. H. OGDEN

ATLANTA PAPER CO.

ATLANTA 3, GA.



OF STACK DESIGN



SINCE 1924 the service given by thousands of "Thermix Fan Stacks" has proved the soundness of their unique basic design.

Advantages of combining the stack, fan and breeching in a single unit make possible an accurate determination of stack efficiency under any given condition.

Draft losses from bends in breeching are eliminated thus minimizing stratification. Gases leaving the fan enter the divergent stack directly where gradual diffusion occurs until the gas is discharged into the atmosphere. "Impact resistance" is thus reduced.

Installation problems are eliminated by the exclusive "Thermix Fan Stack" design which permits direct mounting on the boiler. Breeching to the stack is unnecessary —installation and material costs are reduced proportionately. Write for the bulletin on Thermix Stacks.

•

THERMIX ENGINEERING COMPANY

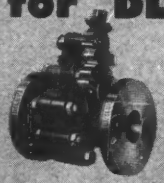
Project and Sales Engineers

FIRST NATIONAL BANK BLDG., GREENWICH, CONN.

PRAT-DANIEL CORPORATION

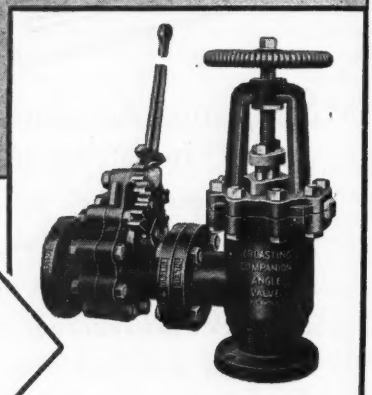
EAST PORT CHESTER, CONN.

CO-ORDINATED for BLOW-OFF SAFETY



THIS IS THE SEALING VALVE

THIS IS THE BLOWING VALVE



EVERLASTING DUPLEX BOILER BLOW-OFF UNIT, COMPLETE

A "REGULAR" Everlasting Valve that opens fully with one short movement of the lever . . . a wheel-operated Everlasting Companion Valve built to take the full punishment of the blow-off . . . these two valves, coupled together, provide a combination that meets full code requirements for dual-valve blow-off.

The lever-operated Everlasting Valve, designed for unimpeded, straight-through flow, maintains its tight seal, because it re-grinds itself with each operation. It cannot wedge or stick.

The Everlasting Companion Angle Valve, designed specifically for blow-off service, stoutly resists erosive blow-off water and the abrasive action of solids in such water.

Either valve obtainable separately if desired.

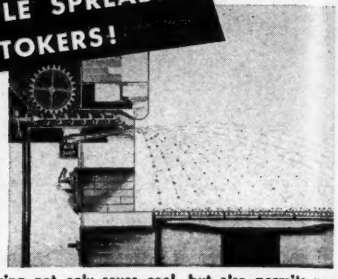
For full information write us for Everlasting Bulletin E-100.

EVERLASTING VALVE CO.
49 Fisk St. Jersey City 5, N. J.

Everlasting Valves

for everlasting protection

SAVE COAL WITH FYR-FEEDER MULTIPLE SPREADER STOKERS!



Write today. Ask for new Catalog describing FYR-FEEDER design and features.

FYR-FEEDER stoker firing not only saves coal, but also permits you to burn any kind of bituminous coal available—screenings or sweepings, any melting point of ash, free-burning or coking coals. WET COAL is no handicap . . . Fyr-Feeders are designed to handle WET or dry coal.

FYR-FEEDER burns fines in suspension, burns larger pieces on grate. Coal is spread over entire fuel bed. Thin fuel bed—no clinkers. Fires can be cleaned in two minutes! Suitable for large or small boilers. Very little maintenance cost. In many cases FYR-FEEDER stokers have made it unnecessary to add another boiler to handle loads. WRITE FOR CATALOG.

AMERICAN COAL BURNER CO.
ENGINEERS, EST. 1918
22-18 East Erie Street Chicago 11, Illinois

LET'S FINISH THE JOB

★

Until the final shot is fired, "Victory" is not fully written. To speed that day buy War Bonds now . . . Buy more Bonds and hold them

★

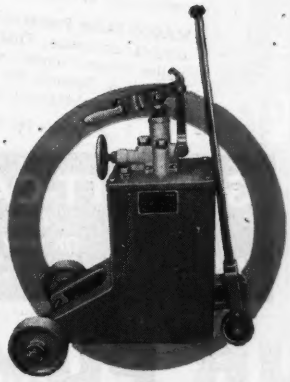
6th WAR LOAN

TEN THOUSAND POUNDS PRESSURE

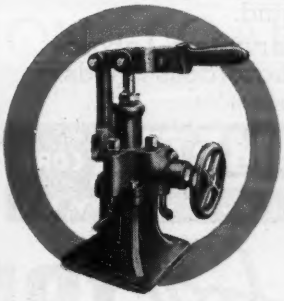
AT YOUR FINGER TIPS!

Single Plunger Pump on Medium Tank

Double Plunger Pump on Large Tank



Single Plunger Pump on Portable Truck



Single Plunger Pump on Stand

Pump with Machine Steel Body, 30,000 lb. capacity

Watson-Stillman Hydraulic Hand Operated Pumps are self-contained units equipped with single or double plungers. These pumps are especially suitable for hydrostatic testing of pipe, valves, fittings, boilers and any equipment requiring an internal test. They are also used to operate hydraulic jacks, small machines and presses.

The single plunger type is available in pressure ranges from 1500 lbs. to 10000 lbs. per sq. in., and can be mounted on three different capacity tanks, 180, 400 and 1500 cu. in. Can also be furnished mounted on stand and portable truck.

The double plunger type has a large and a small concentric plunger. The small plunger is directly connected to the hand lever and produces the high pressure. The large plunger can be locked to the small one by a simple turn of a clutch and produces four times the volume at one quarter of the pressure that the small plunger delivers.

The double plunger pumps are available in pressures ranging from 1500 lbs. to 10000 lbs. per sq. in., and can be mounted on 400 cu. in. or 1500 cu. in. capacity tanks.

Special hand pumps with machine steel bodies can be furnished for pressures up to 30,000 lbs.

All pumps can be furnished with hydraulic gauges

Complete details on all types are given in Bulletin 240-A. Distributor Products Division of The Watson-Stillman Co., Roselle, N. J.

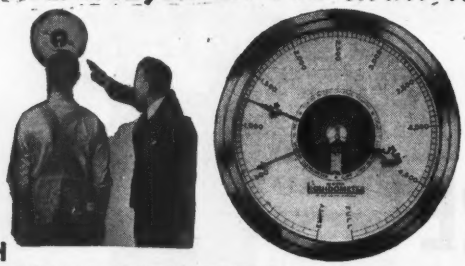
Sold through leading distributors

FEATURES:

- Hardened Tool Steel or Bronze Plungers
- Bronze Pump Body
- Bronze Valves, Seats and Bonnets
- 26" Extension Lever
- Left-Hand Pressure Connection
- Pressure Release Control Wheel
- Reservoir high grade cast-iron
- All parts readily accessible

WATSON-STILLMAN

ACCURATE LIQUID LEVEL INFORMATION AT A GLANCE, WHEN YOU WANT IT—



WITH

LIQUIDOMETER *Tank Gauges*

"THEY'RE ALWAYS DEPENDABLE"

100% automatic.

No pumps, valves, or auxiliary units needed to read them.

Models available for either remote or direct readings.

Accuracy unaffected by specific gravity of tank liquid.

Approved by Underwriters' Laboratories for gauging hazardous liquids.

Write for complete details.

THE LIQUIDOMETER CORP.
36-31 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

HOW MAGIC BOILER PRESERVATIVE *Guards 2 Ways Against Corrosion*

Corrosion occurs when oxygen or acid gases act on metal. Oxygen and carbonic acid gas are found dissolved in all natural waters to a varying degree. Hydrochloric acid gas is formed under steaming conditions, when chlorides of iron, magnesium, calcium or sodium are present in feedwater. The liberation of hydrochloric acid gas from these substances is accelerated by the presence of sulfates of calcium and magnesium. Carbonic acid gas is liberated from bicarbonates of calcium and magnesium.

MAGIC Boiler Preservative acts in two ways to guard against corrosion. First, the MAGIC dissolved in the boiler water "binds" acid gases and represses their liberation. Second, the MAGIC film of protection keeps corroding substances from contact with the metal.

Write for Descriptive Bulletin.

GARRATT-CALLAHAN CO.
Established 1904
OF ILLINOIS — 59 East Van Buren St., Chicago 5
OF NEW YORK, Inc. — 1328 Broadway, New York City 1
OF CALIFORNIA — 148-156 Spear St., San Francisco 5

Write for data, specifying number of bulletin wanted.

for YOUR PUMP FILE

Bulletins, Catalogs and Engineering Data on

BLACKMER ROTARY PUMPS

and the ***"Bucket Design"*** (swinging vane) principle that makes these pumps self-adjusting for wear.

Consider this pumping economy for your plant NOW.

BLACKMER PUMP COMPANY
20112 Century Ave. Grand Rapids 9, Mich.

POWER PUMPS • HAND PUMPS • EZY-KLEEN STRAINERS

DEPENDABILITY!

Manzel Chemical Feeders are unexcelled for injecting boiler compound. Their simple design and sturdy construction insure positive, dependable operation day after day.

Installed directly on the boiler feed pump, they inject exactly the required amount of chemical on each pump stroke. Thus, every gallon of water is treated uniformly. Feed is easily set and very accurate.

Only the pumping unit comes in contact with the chemical, and it is easily removed for cleaning or replacement. All driving parts run in oil.

Model CH-40TS

Write for Bulletin

MANZEL BROTHERS COMPANY
327 Babcock St., Buffalo 10, N. Y.

A Full Year's Guarantee

is your protection against disappointment when you specify Hercules Seamless Copper Floats. It's our protection, too, because, if anything were to go wrong with a Hercules Float, we would be the first to hear about it. In 49 years, not one has been returned excepting by reason of faulty or non-understandable specifications. So, you have no trouble, we have no trouble, and you come back to us for more.

HERCULES FLOAT WORKS
200 Franklin St. Springfield, Mass.

You know what you're getting when you buy...

Champion Coal...

THE NAME THAT MEANS FULL VALUE

PITTSBURGH COAL COMPANY

For V-DAY BUILDING

BENEFIT BY CONNERY V-STIFFENED NON-BUCKLING LEAKPROOF BREECHINGS . . . .

We take pardonable pride in the fact that 100% of Connery output is going to war production projects. And we feel certain that the many plants using (and planning to use) Connery's Improved Expansion Stiffened Construction for stacks, breechings, ducts, etc., won't mind if we give our best to "our first customer," Uncle Sam.

As government priority construction slackens, however, we will be in a position to offer old and new customers specific help on their problems of power plant construction.

STACKS
•
BREECHINGS
•
UPTAKES
•
HOPPERS
•
AIR DUCTS

RECENT INSTALLATIONS

NEW HAMPSHIRE GAS & ELECTRIC CO.
PORTSMOUTH, N. H.
UNITED ILLUMINATING CO.
BRIDGEPORT, CONN.
ROCHESTER GAS AND ELECTRIC CO.
ROCHESTER, N. Y.
INDIANAPOLIS POWER & LIGHT CO.
INDIANAPOLIS, IND.
CONSOLIDATED GAS ELEC. & LIGHT PR. CO.
BALTIMORE, MD.
VIRGINIA PUBLIC SERVICE CO.
ALEXANDRIA, VA.
U. S. NAVAL TRAINING STATION
GREAT LAKES, ILL.
HENRY DISSTON SONS
PHILADELPHIA, PA.
QUARTERMASTERS DEPOT
PHILADELPHIA, PA.

CONNERY CONSTRUCTION CO.
Second and Luzerne Sts. Philadelphia, Pa.

CONNERY
EXPANSION STIFFENED
CONSTRUCTION

Use **VULCODISC**

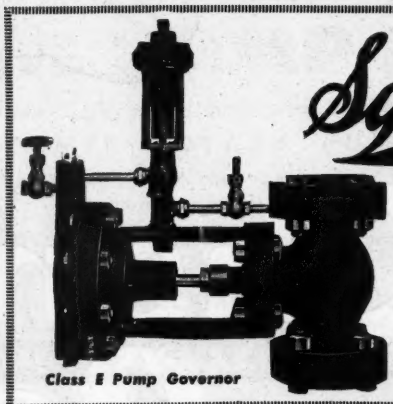
for trouble-free valve jobs

In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact its absorption is less than 1 per cent . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.
Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

The Genuine
Squires



Class E Pump Governor

For True Regulation on Boiler Feed Pumps

The C. E. Squires Co.
E. 40th Street and Kelley Avenue
Cleveland, O.
Catalog E-12 explains

Reminder for Advertisers

Please send reservations and copy on or before **10th** of preceding month; complete plates can be accepted up to **17th.** Be an "early bird"—help us mail issues on time. . . . . .

This boiler is in
COMPLETE CIRCULATION
before
STARTING THE FIRE

ENGINEERS quickly recognize the advantages of operating a boiler that is in full circulation from zero to maximum load. This is an outstanding feature of the International LaMont Forced Recirculation Boiler.

Before starting the fire, and continuously thereafter, the forced recirculation pump, delivers to each tube many times as much water as the tube can evaporate. Each tube is always, therefore, wet throughout its entire length, preventing any possibility of unstable "flash" conditions or overheating and scaling of tube surfaces at any load.

Other advantages of design permit:

Higher efficiencies due to maximum radiant heat absorbing surface in furnace water-walls and effective arrangement of secondary heating surfaces.

Extreme flexibility — follows swinging load from no load to maximum load instantaneously.

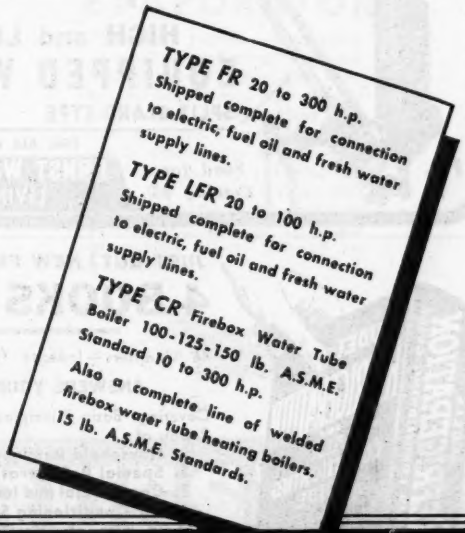
Steady water line and dry steam under all load conditions.

Minimum space requirements — low headroom a feature.

*International-LaMont Boilers, Type LFS, are designed for firing with oil, gas, pulverized coal or stokers. They are available in capacities ranging from 4,000 to 30,000 pounds of steam per hour and in all standard working pressures. Designs for larger sizes and special pressures or superheat requirements on request.

Write today for bulletin illustrating and describing special features of this Type LFS Boiler.

*Licensed under LaMont patents.


TYPE FR 20 to 300 h.p.
Shipped complete for connection to electric, fuel oil and fresh water supply lines.
TYPE LFR 20 to 100 h.p.
Shipped complete for connection to electric, fuel oil and fresh water supply lines.
TYPE CR Firebox Water Tube Boiler 100-125-150 lb. A.S.M.E. Standard 10 to 300 h.p.
Also a complete line of welded firebox water tube heating boilers. 15 lb. A.S.M.E. Standards.

Boiler Builders for 58 Years

THE INTERNATIONAL BOILER WORKS CO.
POWER DIVISION
240 BIRCH STREET · EAST STROUDSBURG, PA.

MERCOID

The Only 100% Mercury Switch Equipped Controls

FOR HEATING, AIR CONDITIONING, REFRIGERATION, AND INDUSTRIAL APPLICATIONS

The acceptance of Mercoid Controls is universal. The reason is based on their record for dependable operation and long service. They are easy to install, adjust, and require practically no attention.

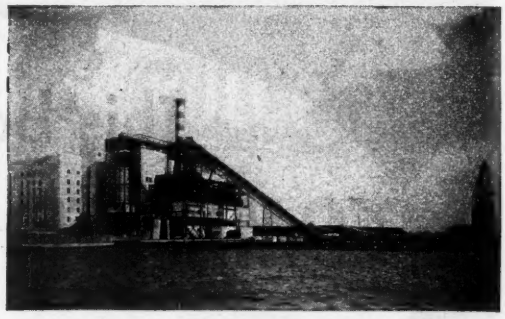
The hermetically sealed mercury switches used in all Mercoid Controls are dust, dirt and corrosion-proof, thus assuring positive performance under all operating conditions.

Pressure Control—*For various industrial applications. The operating range is plainly indicated on a visible dial. Adjustments are easily made.*

Temperature Control—*For numerous applications. The operating range is plainly indicated on a visible dial. No guesswork—easy to adjust.*

See catalog No. 600 for complete information on all types of Mercoid Controls.

THE MERCOID CORPORATION
4229 West Belmont Avenue, Chicago 41, Illinois



One of America's Latest Stations

Coal Preparation by "Pennsylvania" Bradford-Hammermill

"Pennsylvania" STEELBUILT Coal Preparation Machinery, developed during the past 40 years, in six types and over 150 sizes, has been specialized for the requirements of Central Stations, Industrial Power Plants, By-Product Coke Plants, Mines and Coal Cleaning Plants.

Experience with a rapidly increasing number of installations, with capacities now totaling well over 200,000,000 tons per annum, is the basis for our recommendations of efficient Coal Preparation Equipment, specialized for your requirements.

Our Engineers are at your service

PENNSYLVANIA CRUSHER COMPANY

1706 Liberty Trust Bldg., Philadelphia 7, Pennsylvania
New York, Pittsburgh, Chicago, Los Angeles, Birmingham
Associated with Fraser & Chalmers Engineering Works, London

Specify: ERNST

HIGH and LOW Alarm Water Columns
EQUIPPED WITH INCLINED GAGES
SPLIT GLAND TYPE OR PRISMATIC REFLEX TYPE
FOR ALL PRESSURES AND TEMPERATURES

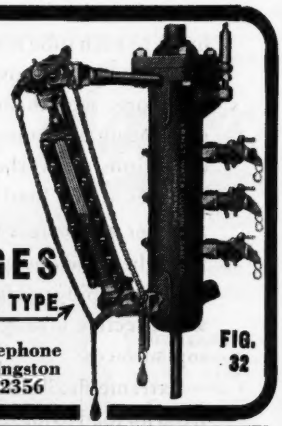


FIG. 1

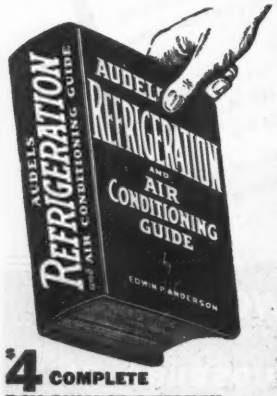
Send for Catalog 45

ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, NEW JERSEY

Telephone Livingston 6-2356

FIG. 32

JUST OUT! NEW FROM COVER TO COVER • 1280 PAGES • FULLY ILLUSTRATED



$4 COMPLETE
PAY ONLY $1 A MONTH

4 BOOKS IN ONE!

46 Chapters — Indexed for Ready Reference —

ANSWERS YOUR QUESTIONS

Covering: Basic Principles, Servicing, Operation, Repair of

1. **Household Refrigeration**
2. **Special Refrigeration Units**
3. **Commercial and Industrial Refrigeration**
4. **Air Conditioning Systems**

A gold mine of essential important facts for ENGINEERS, SERVICEMEN and USERS.

Here you have at your fingers' ends a Complete Library in ONE VOLUME, the necessary data you have been looking for on: MODERN UNITS, SYSTEMS AND MACHINES, REFRIGERANTS including Freon, Quick Freezing, Lockers, Water Coolers and Air Conditioning Systems.

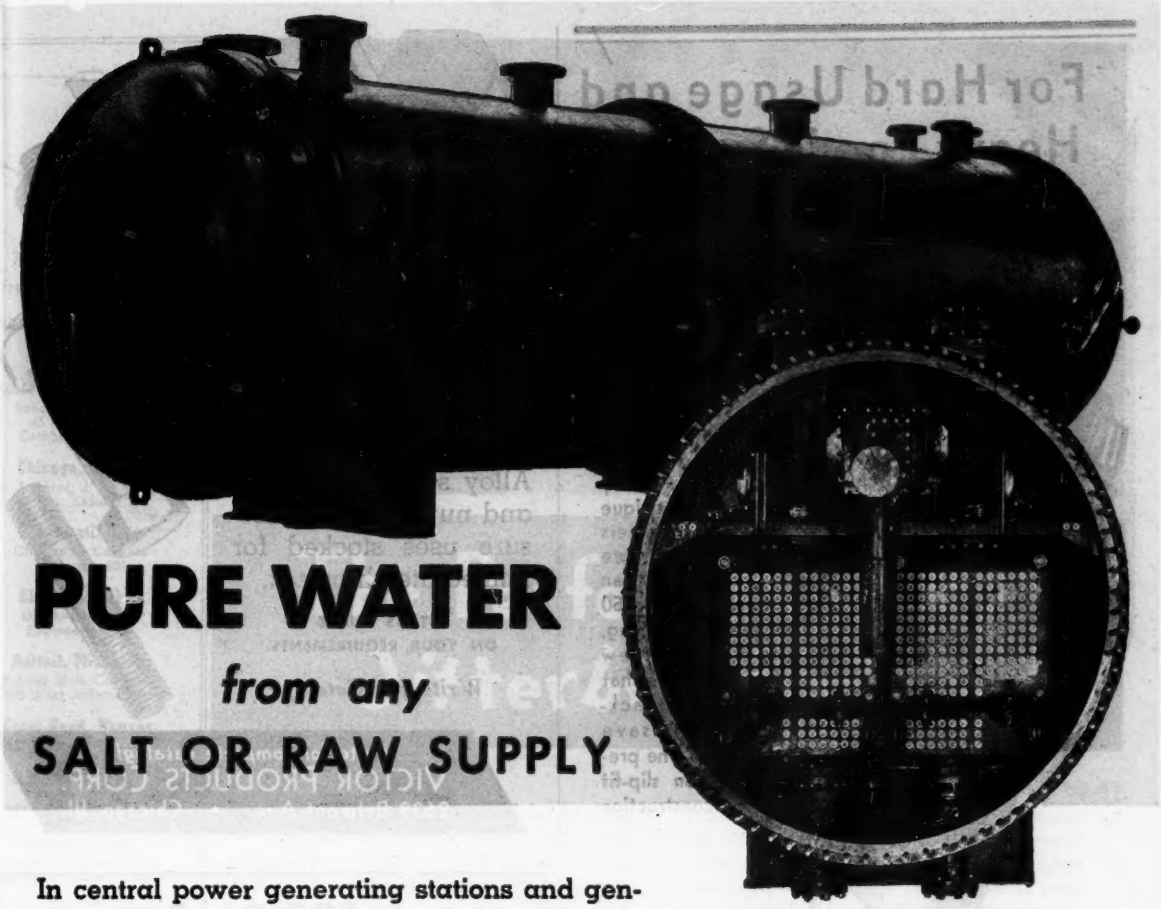
AUDELS REFRIGERATION and AIR CONDITIONING GUIDE

ASK TO SEE IT!

To get this information for yourself, mail coupon today. No obligation unless satisfied.

AUDEL, Publishers, 49 W. 23rd St., New York 10, N. Y.
MAIL AUDELS NEW REFRIGERATION GUIDE for free examination. If O. K. I will send you $1 in 7 days; then remit $1 monthly until price of $4 is paid. Otherwise I will return it.

Name_____
Address_____
Occupation_____
Employed by_____ PPE



PURE WATER

from any

SALT OR RAW SUPPLY

In central power generating stations and general industrial plants . . . on naval and commercial vessels . . . in refineries and chemical process plants . . . wherever pure water is required for boiler feed make-up, process work, or general services . . . G-R Evaporators have established records for dependable, economical operation. These units do not require hand-scaling, and can be maintained by unskilled labor. Varying raw water conditions do not affect the product under wide limits. The distillate produced meets the exacting purity requirements of present day practice.

Look into this G-R BENTUBE EVAPORATOR

Note the rugged construction, unusually large clearances, and widely spaced tubes. The heating surface of this unit consists of patented scale-shedding Bentube elements. Temperature variations change the curvature of the tubes, thereby shedding the scale. G-R Bentube Evaporators can be furnished for large or small capacities, and in single or multiple effects for any requirements.

THE GRISCOM-RUSSELL CO., 285 Madison Ave., New York 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

For Hard Usage and Heavy Loads Specify

AIRETOOL

TUBE CLEANERS AND EXPANDERS

The manufacture of tube cleaners and tube expanders that give maximum service under the most extreme conditions is Airetool's aim. And this aim is a reality because of Airetool's unique developments. In Cleaners they are Airetool's more powerful motor that can be loaded down to 50 rpm without stalling, the Airetool new form cutters that eliminate tracking and save tubes, the precision slip-fit construction of special alloy steel and other features. In Expanders they are the special tested designs, the precision construction, their long life and others. No wonder users everywhere say Airetool Cleaners and Expanders are "Tops."

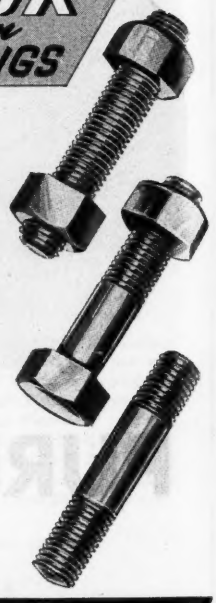
Airetool Cleaners are made for tubes ½" to 24" I.D.; straight or curved. Airetool Expanders are made for tubes ½" to 12" I.D.

Write Dept. PY for informative, instructive literature.

AIRETOOL MANUFACTURING COMPANY

Airetool & Yost - Superior Factory Bldg.
SPRINGFIELD, OHIO

VICTOR Custom FASTENINGS



for Power Plants and all Heavy Industries

STUDS • BOLTS • NUTS

Heat and corrosion resisting metals and high strength alloy steels.

Alloy steel studs, bolts and nuts for high pressure uses stocked for immediate shipment.

LET US QUOTE ON YOUR REQUIREMENTS.

Write for Catalog

Write for complete catalog!
VICTOR PRODUCTS CORP.
2639 Belmont Ave. • Chicago, Ill.

FOR SALE

New and Reconditioned Iron and Steel **VALVES**

ALL TYPES AND SIZES
ALSO FITTINGS

Tested and Guaranteed

APEX IRON & METAL CO.
2204 S. Laflin St. Chicago 8, Ill.

FOR SALE

1—Steam Tight valve counterflow engine, heavy duty, center crank, right hand automatic. For direct connection to a 200 true kilowatt alternating current generator with belted exciter complete. Size 20x20". Engine No. 9899.

1—Steam Tight valve counterflow engine, heavy duty, center crank, automatic, direct connected, for 210-kv.a. alternating current generator with belted exciter, with type TRE General Electric Generator, size 18x18", 60 cycle—220 volts, less switch board instruments. Engine No. 10410.

Buyer to arrange for loading on car or truck.

THE JOHN DOUGLAS COMPANY

Factory and General Office, Cincinnati 16, Ohio

Sales Representatives
from Coast to Coast

Birmingham, Alabama
Harry G. Mouat
544 Martin Bldg.

Boston, Massachusetts
Bellamy-Robie, Inc.
45 Main Street
Cambridge, Mass.

Chicago, Illinois
E. J. Ehret, J. D. Kinney
327 So. LaSalle St.

Cincinnati, Ohio
Charles A. Colgate
P. O. Box 803

Cleveland, Ohio
Dingle-Clark Co.
Engineers Bldg.

Detroit, Michigan
Palmer Shile Company
7100 West Jefferson Ave.

Great Bend, Kansas
Scheufler Supply Co., Inc.

Hartford 7, Conn.
Roger C. Jones
967 Farmington Ave.

Houston, Texas
Industrial Equipment Co.
6823 Navigation Blvd.

Los Angeles, California
J. S. Earhart
1709 W. Eighth Street

New Orleans, Louisiana
Factory Sales and
Engineering, Inc.
816 Howard Avenue

Philadelphia, Penn.
Dingle-Clark Co.
1600 Arch St.

Pittsburgh, Penn.
Edward B. Gray
1011 Keystone Bldg.

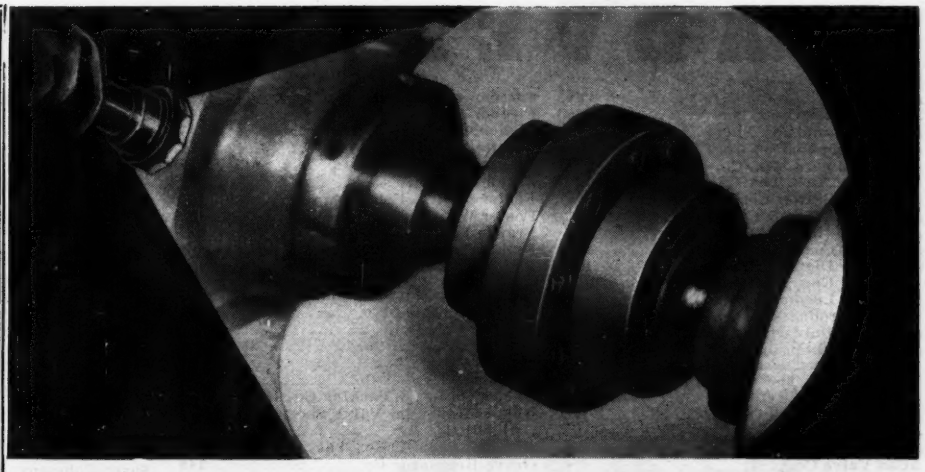
Portland, Oregon
Western Gear Works
610 Lewis Bldg.

San Francisco, Calif.
Pacific Gear & Tool Works
1035 Folsom Street

Seattle, Washington
Western Gear Works
417 Ninth Ave. South

St. Louis, Missouri
Transmission Supply Co.
3429 Chouteau Ave.

St. Paul, Minnesota
Northwestern Power
Equipment Co.
2295 University Ave.



The Perfect Cure For Jitterbug Shafts

It does make a difference which coupling is selected to correct your shaft misalignment troubles. Take the case of a motor generator shaft that becomes misaligned and develops the jitters. An ordinary flexible coupling in trying to take up the misalignment can fatigue and strain shaft and bearings. That means costly repairs—more time and production lost!

* * *

The Waldron Gear Type Coupling is designed and constructed to avoid all 4 major causes of such stoppages. It has no flexible hub connections to fatigue; it affords freedom of movement between cover sleeve and hub to eliminate stress on shaft and bearings. Its forged steel parts and automatic pressure lubrication of all moving parts prevents excessive wear and the need for frequent repair and replacement. An ingenious and positive seal keeps a constant supply of CLEAN oil inside the coupling guarded against contamination from outside dust and dirt.

Compare the design and operating features of this Waldron coupling with those of any other make. Then you will understand why it is being specified in so many plants where trouble-free operation is a major consideration.

Get in touch with the Waldron Representative nearest you. Our Catalog No. 56 gives full details, rating tables, etc. Sent on request.

GEAR

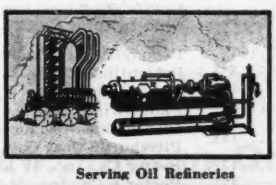
WALDRON TYPE **COUPLING**

Manufactured by

JOHN WALDRON CORP. New Brunswick, New Jersey

Serving Public Utilities

Serving the Shipbuilders



Serving Oil Refineries

Serving Industrial Plants

ADVERTISERS

Airetool Mfg. Co. 202
Air Preheater Corp., The 129
Aldrich Pump Co., The .... *
Allen-Sherman-Hoff Co. .... *
Allis-Chalmers Mfg. Co. 40-41, 61
Allpax Co., Inc., The 170
American Blower Corp. 14-15
American Chain & Cable Co., Inc. 141
American Chimney Corp. 174
American Coal Burner Co. 194
American District Steam Co. 190
American Engrg. Company 20-21
American Locomotive Co. (Alco Products Division) 163
American Pulverizer Co. .... *
American Radiator & Standard Sanitary Corp. 14-15
Anderson Co., The V. D. .... *
Apex Iron & Metal Co. 202
Arkansas Fuel Oil Co. 42
Armstrong Machine Works 22-23
Atlanta Paper Co. 192
Atlas Valve Co. .... *
Audel & Co., Theo. 200

Babbitt Steam Specialty Co. 188
Babcock & Wilcox Co., The 46-47
Babcock & Wilcox Tube Co., The .... *
Bacharach Ind. Inst. Co. 188
Bailey Meter Co. 12-13
Baldwin-Hill Co. 140
Baldwin Locomotive Works 123
Beaumont Birch Company .... *
Belmont Packing & Rubber Co., The ..146
Bendix Aviation Corp. 168
Betz, W. H. & L. D. 119
Biddle Co., James G. 134
Bird-Archer Co., The .... *
Blackmer Pump Co. 196
Bonney Forge & Tool Wks. .... *
Bowser, Inc. .... *
Brickseal Refractory Co. 170
Bridgeport Brass Co. 58
Briggs Clarifier Co. .... *
Brown Instrument Co. 48
Builders-Providence, Inc. 184
Burgess-Manning Co. 125
Busch-Sulzer Bros. Diesel Engine Co. 64

Canton Stoker Corp. .... *
Cash Co., A. W. .... *
Chapman Valve Mfg. Co., The ....Inside Back Cover
Chesterton Co., A. 166
Chicago Metal Hose Corp. 142
Cities Service Oil Company 42
Cleaver-Brooks Co. .... *
Clipper Mfg. Co., The .... *
Cochrane Corporation 39, 65, 166
Combination Pump Valve Co. .... *
Combustion Control Corp. .... *
Combustion Engrg. Co., Inc. 24-25
Condenser Service & Engrg. Corp. 157
Connery Construction Co. 198
Cook's Sons, Inc., Adam .... *
Corning Glass Works 174
Crane Co. 113
Crane Packing Co. 111
Crocker-Wheeler Elec. Mfg. Co. .... *
Cutler-Hammer, Inc. ....Back Cover

Dampney Company of America, The ..159
Dart Mfg. Co., E. M. 144
Davis Engrg. Corp. .... *
Davis Regulator Co. .... *
Dearborn Chemical Co. .... *
De Laval Separator Co., The .... *
De Laval Steam Turbine Co. 53, 176
Detrick Co., M. H. .... *
Detroit Stoker Co. 50-51
Douglas Co., The John 202
Dowell, Incorporated 59

Edge Moor Iron Works, Inc. 167
Edward Valve Mfg. Co., Inc., The ..161-162
Elgin Softener Corp. 27
Elliott Co. 2-3
Engineer Co., The 176
Ernst Water Column & Gage Co. 200
Ess Instrument Co. 190
Everlasting Valve Co. 194

Fairbanks Co., The 139
Fairbanks, Morse & Co. 171
Fairmont Coal Bureau 189
Fischer & Porter Co. 183
Fisher Governor Company 145
Flexitallic Gasket Co. 60
Flexrock Co. 192
Flynn & Emrich Co. .... *
Foster Engrg. Company 136
Foster Wheeler Corp. 28-29
France Packing Co., The 172
Fuller Company .... *
Fyr-Feeder Spreader Stoker Div. 194

Garlock Packing Co., The .... *
Garratt-Callahan Co. 196
General Coal Co. .... *
General Electric Co. 35-38, 127
Gifford-Wood Co. .... *
Globe Steel Tubes Co. 132
Goetze Gasket & Packing Co., Inc. .... *
Golden-Anderson Valve Specialty Co..130
Grinnell Co., Inc. .... *
Griscom-Russell Co., The 201
Grove Regulator Co. 149

Haering & Co., Inc., D. W. 156
Hagan Corporation 32-33, 44-45
Hall Laboratories 32-33, 44-45
Hays Corporation, The 115
Hendy Iron Works, Joshua 131
Henszey Company 138
Hercules Float Works 196
Hills-McCanna Co. 178
Honan Crane Corp. .... *
Huyette Co., Inc., The Paul B. 148

Infilco, Incorporated .... *
Ingersoll-Rand Co. .... *
International Boiler Works Co., The..199
International Nickel Co., Inc., The 56
Iron Fireman Mfg. Co. .... *

Jenkins Bros. 133
Johns-Manville .... *

Keasbey & Mattison Co. .... *
Keeler Co., E. .... *
Kellogg Co., The W. M. .... *
Kennedy Valve Mfg. Co., The 137
Kieley & Mueller 192

Ladish Drop Forge Co. 135
Leavitt Machine Co., The .... *
Leeds & Northrup Company 52
Leslie Company .... *
Link-Belt Co. 169
Liquidometer Corp., The 196
Loew's, Inc. .... *
Lummus Co., The 155
Lunkenheimer Co., The 109

Manzel Bros. Co. 196
Marley Company, Inc., The 55
Mason-Neilan Regulator Co. .... *
Maxim Silencer Company, The 6
McAlear Manufacturing Company .... *
McGraw-Hill Book Co., Inc. 182
Mercoid Corp., The 200
Midwest Piping & Supply Co., Inc. ...181
Miller Tool Sales, J. C. .... *
Minneapolis-Honeywell Reg. Co. 48
Mitchell & Co., W. K. 188
Murray Iron Works Co. 170

National Aluminate Corp. 107
National Boiler Protector Co. 166
National Valve & Mfg. Co. 147
Niagara Blower Co. 154
Nicholson & Co., W. H. 176
Northern Equipment Co. 117
Norton Company 173
Nugent & Co., Inc., Wm. W. .... *

Oakite Products, Inc. 164
Ohio Injector Co., The .... *

Pennsylvania Crusher Co. 200
Permutit Co., The .... *
Philadelphia Gear Works .... *
Photoswitch, Inc. .... *
Pipe & Tube Products, Inc. 152
Pittsburgh Coal Co. 197
Porter Co., Inc., H. K. 156
Porter & Co., Inc., H. W. .... *
Powell Co., The Wm. 128
Power Engrg. Co. .... *
Power Show, National .... *
Powers Regulator Co., The .... *
Prat-Daniel Corp. 193
Pritchard & Co., J. F. .... *
%Proportioneers, Inc. % .... *

Quaker Rubber Corporation .... *
Quimby Pump Co., Inc. 156

Raybestos-Manhattan, Inc. 164
Raytheon Mfg. Co. 187
Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc. 141
Refinery Supply Co., Inc. 186
Reliance Gauge Column Co., The .... *
Rempe Co. .... *
Republic Flow Meters Co. 18
Richardson Scale Company .... *
Roto Company, The 172
R-S Products Corp. .... *

Sarco Company, Inc. 43
Saverite Engrg. Co. .... *
Scovill Mfg. Co. .... *
Sea-Ro Packing Co. 62
Shell Oil Co., Inc. 9
Simplex Valve & Mfg. Co. 26
Sims Company, The .... *
Sinclair Refining Co. 34
Skinner Engine Co. 177
Smooth-On Mfg. Co. 186
Socony-Vacuum Oil Co., Inc. .... *
Springfield Boiler Co. .... *
Squires Co., The C. E. 198
Steel Improvement & Forge Co. 175
Stephens-Adamson Mfg. Co. 49
Sterling Engine Co. .... *
Stonhard Co. 178
Strong, Carlisle & Hammond 54
Struthers Wells Corp. 153
Sun Oil Company .... *
Swartwout Co., The 168
Syntron Company .... *

Taylor & Co., W. A. 176
Taylor Forge & Pipe Works 126
Templeton Brothers, Inc. 172
Terry Steam Turbine Co., The 57
Texas Co., The 4
Three-Point Gage Co. .... *
Tide Water Associated Oil Co. 30-31
Titusville Iron Works Division, Struthers Wells Corp. 153
Todd Shipyards Corporation (Combustion Equipment Division) 165
Treasury Department .... *
Troy Engine & Machine Co. 185
Tube-Turns, Inc. 121

Union Iron Works 158
Union Asbestos & Rubber Co. .... *
Union Chain & Mfg. Co., The .... *
U. S. Gasket Co. .... *
United States Rubber Co. .... *

Victor Products Corp. 202
Viking Instruments, Inc. 168
Vogt Machine Co., Inc., Henry 143

Waldron Corp., John 203
Wallace & Tiernan Products, Inc. 150
Warren Steam Pump Co., Inc. 151
Watson-Stillman Co., The 195
Westinghouse Elec. & Mfg. Co. 16-17
Wheeler Mfg. Co., C. H. 190
Wickes Boiler Co., The 190
Wiley & Sons, Inc., John .... *
Williams Gauge Co., The .... *
Williams Valve Co., The D. T. 198
Wilson, Inc., Thos. C. 160
Wing Mfg. Co., L. J. 191
Witte & Burden 186
Worthington Pump & Machy. Corp. 63

Xzit Sales Corp. .... *

Yarnall-Waring Co. 10-11, 19, 66, 180
Yeomans Bros. .... *
Young Radiator Co. .... *

Firms whose advertising is not in this issue but is appearing in other issues are marked with an *

QUICK-ACTING THREADS

NOW ENTIRELY

PROTECTED

The new

CHAPMAN

List 960 Gate Valve

You can expect longer service from this new small forged steel gate valve (which replaces Chapman's Standard List 960). These features *insure* it:

Bonnet now fitted with a substantial forged steel yoke. A flanged forged steel packing gland is provided, thereby eliminating exposed threading on valve yoke, thus giving immunity from rusting and corrosion when placed in exposed locations.

Stems, plugs, and seat rings *on all valves* are heat treated stainless steel to insure greater working qualities.

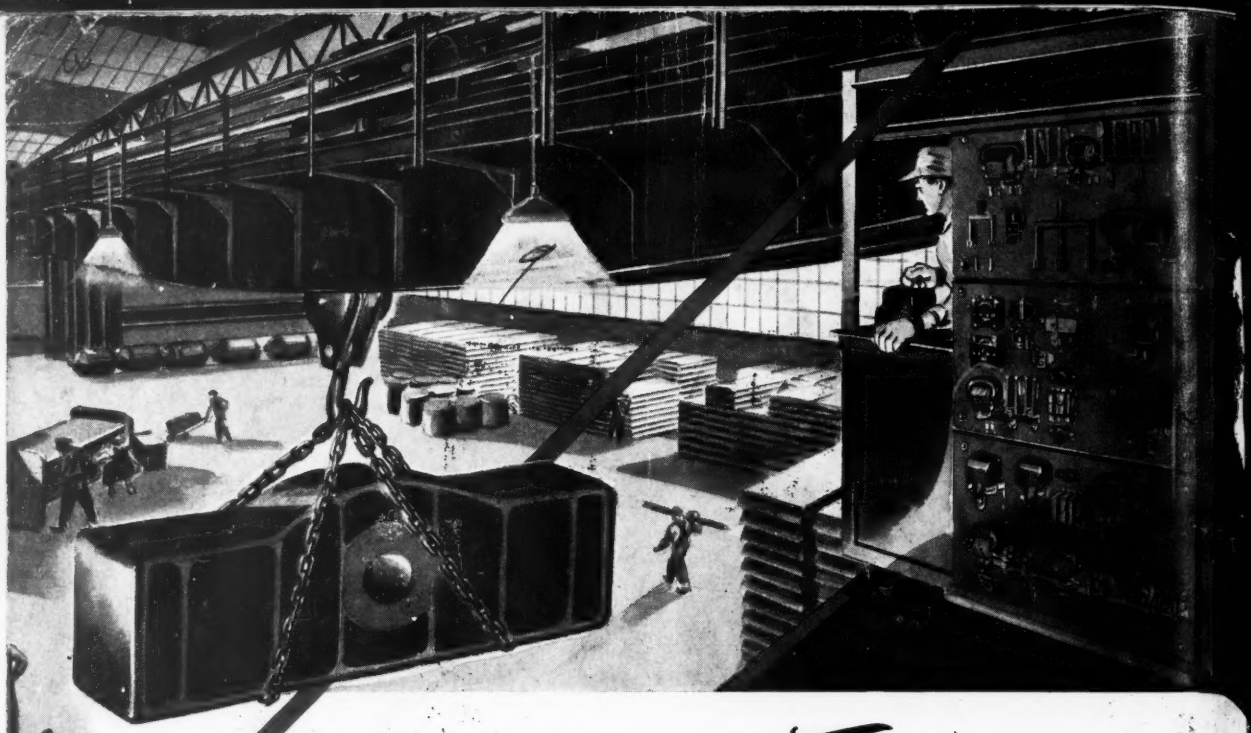
Swivel bolts are used for holding the packing gland.

No gaskets to blow, as in valves with flanged bonnet connections.

Specify List 960 outside screw type in carbon steel for working pressures to 800 lbs. at 750° F. Or in alloy steel for service at 1000 lbs. working pressure at 750° F. Both valves available in screw and welding ends. Where service conditions make it preferable the List 960 rising stem inside screw type is available.

For greater pressures — get Chapman List 990 with heavier walls and extra strength. In sizes up to and including 1½", with screw or welding end.

The Chapman Valve Mfg. Co., Indian Orchard, Mass.



For the first Time

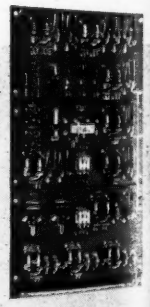
FIVE DEFINITE AND STABLE LOWERING SPEEDS OF CRANE HOISTS

on Alternating Current

It is no longer necessary for crane users to turn to direct current when they want maximum crane hoist performance. It is no longer necessary to put up with costly, troublesome load lowering brakes on alternating current crane hoists. Cutler-Hammer Engineers have solved this problem . . . the problem of getting 5 stable selective speed points—both hoisting and lowering; full dynamic braking; accurate inching; timed acceleration in both directions and timed deceleration for spotting a load . . . *all on alternating current.*

This new Cutler-Hammer AC Crane Control can be used with any standard slip ring crane motor and is available in drum type manual and magnetic types. Specify this outstanding engineering development for your next crane. Write today for full information. CUTLER-HAMMER, Inc., 1392 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
MOTOR CONTROL
C-H

Control engineering ingenuity solved the long-standing problem of how to get crane performance on alternating current. This control panel of standard C-H units does the job with a standard AC motor.

Engineering Excellence finds its Greatest Reward in the Respect and Confidence of those it Serves